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ERRATA

Vol. 94 (2): page 436, The author of the article entitled "*Corydalis pseudo-juncea* Ludlow (Fumariaceae): A new record for India" is D.S. Rawat, not R.S. Rawat. We regret the error.

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ON A RESIDENT POPULATION OF THE GANGES RIVER DOLPHIN *PLATANISTA GANGETICA* IN THE KULSI RIVER (ASSAM) A TRIBUTARY OF BRAHMAPUTRA[1]

R.S. Lal Mohan[2], S.C. Dey & S.P. Bairagi[3]

(*With two text-figures*)

Key words: Ganges river dolphin, Kulsi river, ecology, habitat, population, conservation

A land-locked population of the Ganges river Dolphin, *Platanista gangetica,* was observed in the Kulsi river, a southern tributary of Brahmaputra. Its number has come down from 24 animals in 1992 to 12 in 1995. Large scale sand extraction and operation of fishing gear hazardous to the dolphins are the main causes for the decline in the population. The habitat of the dolphin, the hydrology of river, sand extraction and the fisheries were also studied. Conservation measures are suggested.

INTRODUCTION

The Ganges river dolphin *Platanista gangetica* is found in the river Ganges, Brahmaputra and Meghna and their tributaries (Anderson, 1879; Mohan, 1989 a, 1989 b, 1992; Mohan *et al.* 1993). Recently, while studying the river dolphins of Brahmaputra, a residential population of dolphins was observed in the river Kulsi, one of the southern tributaries originating from the hills of Meghalaya. The Kulsi river is about 80 km in length and it meanders through the Kamrup dist. of Assam. It crosses the National Highway NH 37 near the village Kukumara about 35 km west of Guwahati. (Fig. 1 & 2).

Ganges river dolphins are found throughout the year in the mainstream of Brahmaputra, migrating to the tributaries for feeding during the rainy season. (Reeves *et al.* 1993; Mohan *et al.* 1993; Reeves and Leatherwood, 1994). The land-locked population of river dolphins consisting of adults, adolescents and calves was found in a stretch of about 1 km of the Kulsi river throughout the year. Forty years ago, such a land-locked population was found in Kakdanga, another tributary (Pilleri, 1970). The river is now highly silted and no dolphins are found.

Observations on the Ganges river dolphin of Kulsi river were carried out from 1992 to 1995 to assess the status of its population, to study the ecological degradation of its habitat and to suggest conservation measures.

METHODS

Though the dolphin habitat in Kulsi river was visited periodically, atleast biannually from March 1992 to November 1993, regular monthly observations were carried out from March 1994 to April 1995. Water temperature, turbidity, velocity of water current, sand extraction, fishing

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[1] Accepted April, 1997

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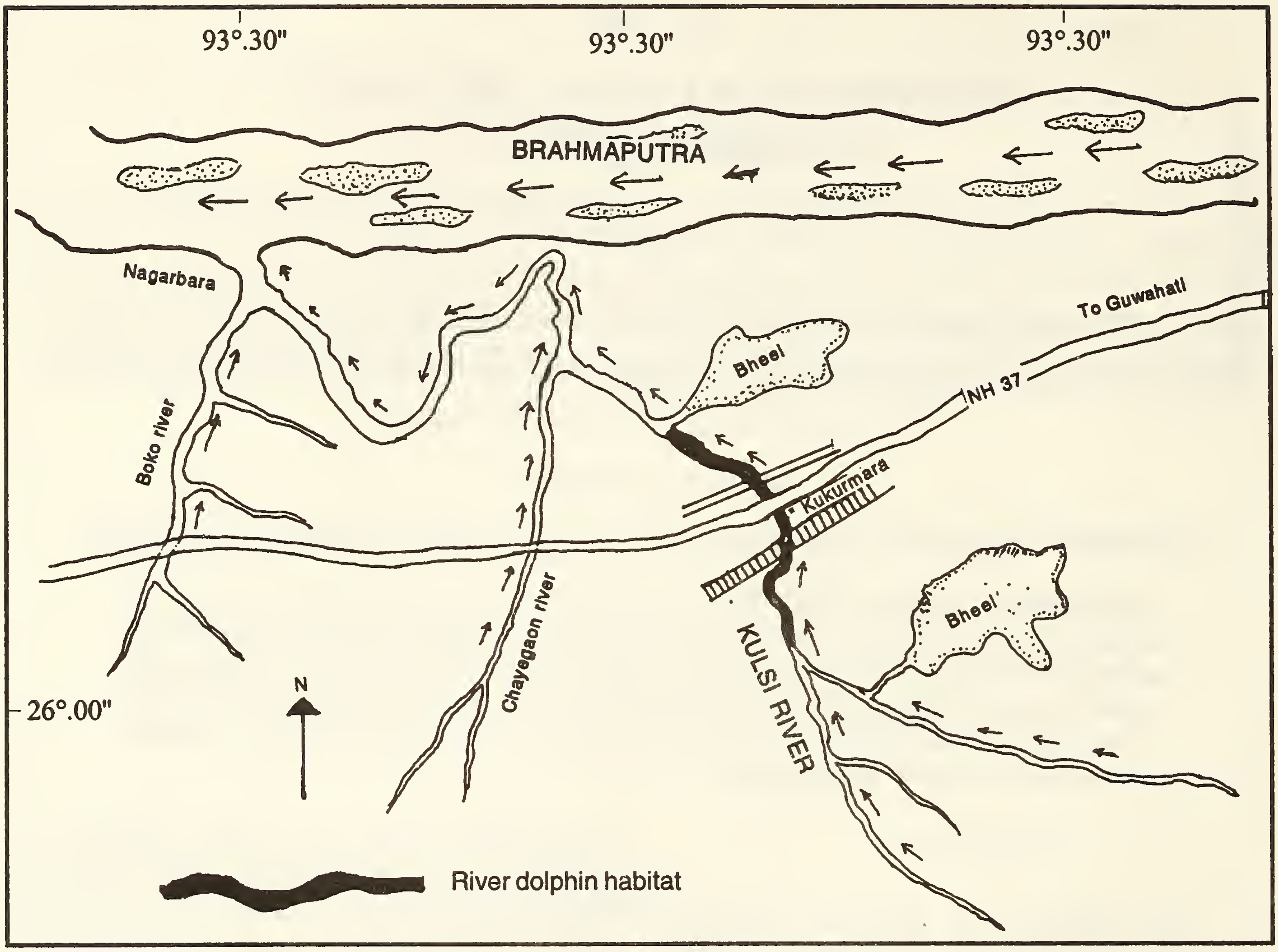

Fig. 1. Brahmaputra river showing the Kulsi river

activities and the species composition of fishes which have a bearing on the ecology of the river dolphins were studied. Two canoes with 2-3 fishermen and 2 or 3 scientific and field staff constituted the investigating team.

The dolphins were counted directly with or without binoculars (6x30) from the canoes. A Canon camera with 70-300 mm zoom lens was also used. The dolphins were counted when they surfaced, taking care to avoid repetition or missing them. For this purpose, body length, distance between the surfacing dolphins, length of the beak (adult females have longer beak) and intervals between surfacing were given due consideration. For example, if 3 dolphins surfaced at the same time they are counted as three; if 5 surface at the same time, they are counted as five. If two dolphins surface at one spot and another 3 at a distance of about 30 m within a second, the number can be assumed as 5. If an adult and a calf surface at different times, they are counted as 2. Usually the monitoring team stayed for more than 30 minutes at the surfacing area to count the population. A video camera was also used and the film was utilised to finalise the dolphin count.

Turbidity was measured using a Sechi disc. Water temperature was recorded with a mercury thermometer. The velocity of water current was measured by allowing a cork coated with white paint to drift for 30 seconds and recording the distance to compute distance travelled by the cork for one hour. Three such readings were taken and the average was estimated.

The number of canoes engaged in sand extraction was counted and the quantity of sand extracted by each boat was recorded to estimate

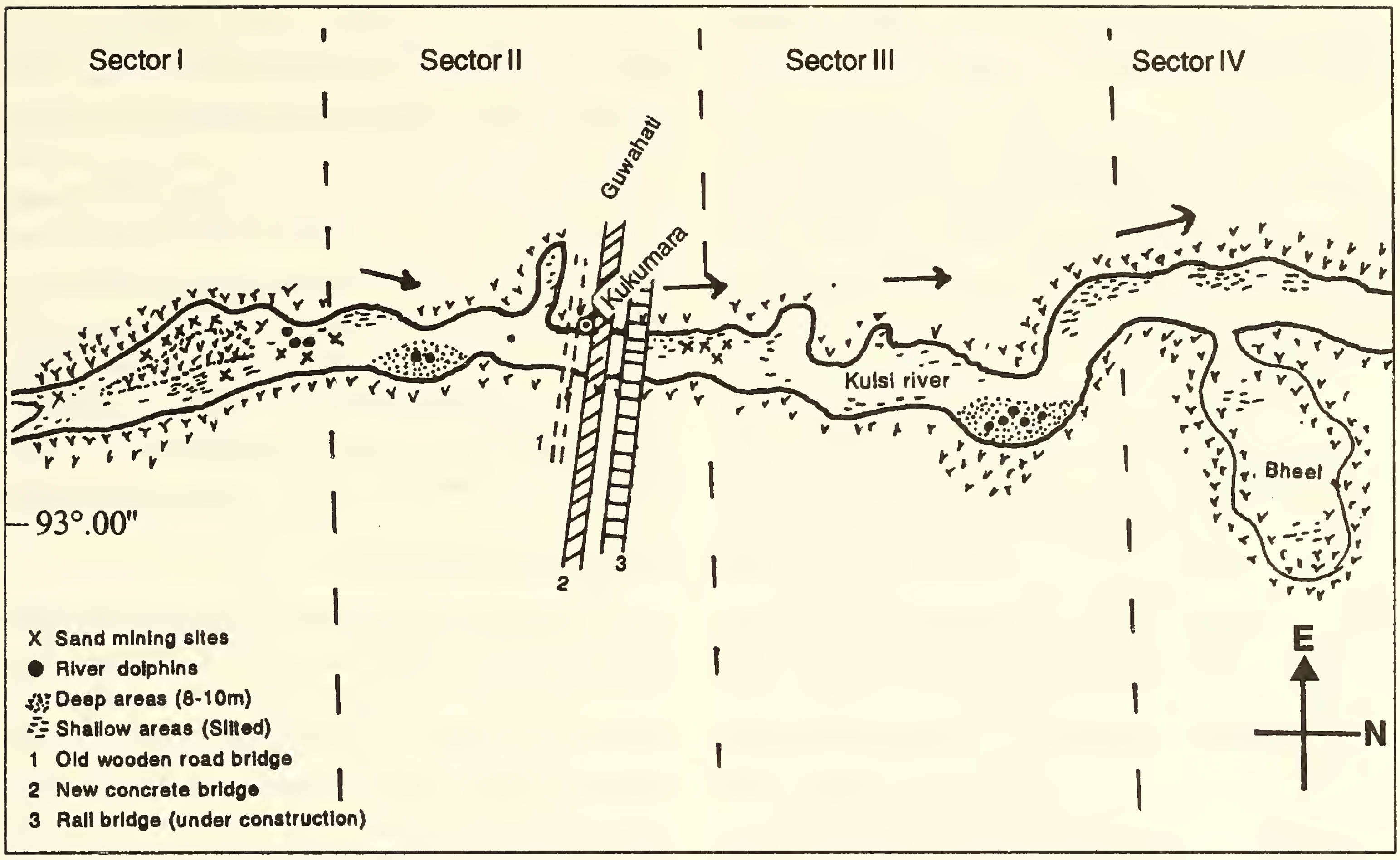
Sector I
Sector II
Sector III
Sector IV
Guwahati
Kukumara
Kulsi river
Bheel
93°.00"
1
2
3
X Sand mining sites
● River dolphins
Deep areas (8-10m)
Shallow areas (Silted)
1 Old wooden road bridge
2 New concrete bridge
3 Rail bridge (under construction)
E
N

Fig. 2. Kulsi river showing the habitat of Ganges river dolphin

total sand extraction per day. The data was verified with the number of lorry loads of sand taken by contractors. Fish landing was estimated by examining the fishes caught by each fishing unit on the day of observation. Fish and prawn samples were collected by the senior author, preserved in 5% formalin and identified to the species level. The numbers of fishing tackle such as hook and line, traps and other devices were also recorded.

RESULTS

1. **Dolphin habitat in the Kulsi river**:

River dolphins were found in 1 km of the river near Kukumara village. Width of the river dolphin habitat ranged from 10-30 m. The depth varied from 1.5 to 10 m during the rainy season from July to August, and 0.3 to 8 m during the dry season. The river was divided into 4 sectors each measuring about 250 m for recording the depth and other landmarks (Fig 2).

Sector I was very shallow with a depth of about 80-100 cm during the wet months from July to August. The upstream of the sector was also very shallow with 30-40 cm of water during September to May. A narrow stream with a strong current of about 33m/minute circumventing an island of about 200m^2 was found in the sector. Dolphins could be found at the confluence of this stream with the mainstream of the Kulsi river. During the dry months an island of 100m^2 was found at the confluence. Large scale sand extraction was carried out in the canal.

Sector II had a trench of about 500m^2 width and depth of about 8m, even during the dry months. The deep area was a good dolphin habitat. The sector was highly turbid and the sand was dumped along the banks here. The banks of the sector was made of hard laterite in the deep areas. An old, dilapidated, unused wooden bridge, a concrete road bridge (NH 37) and a rail bridge were in this sector.

In Sector III the river took a U turn, with an area of 1000m^2 and a depth of 8-10 m. Many dolphins were found here along with calves and forage fishes.

Sector IV was shallow with a depth of about 40 cm in dry months and about 1.50 m in the rainy season. Large areas in the sector and further downstream were exposed during the dry months from October to May.

2. **Hydrology**:

Hydrological conditions such as water temperature, turbidity and the velocity of the current are closely related to the ecology of the dolphins. As the Ganges river dolphin is a fluvial species, water current is important for its long term survival. It has been reported in greater numbers at the confluence of rivers with strong currents (Pilleri, 1970, Mohan *et al.* 1993).

The water temperature varied from 10°C in December to 25°C in April. Water temperature was low as the river drained from the hills of Meghalaya. The turbidity was highest in August during the rainy season. In the upstream of Sector I during March 1995, the Sechi disc reading was 19 cm, while it was only 11-13 cm in the downstream of the sector where intense sand extraction was being carried out. The Sechi disc reading was 17 cm for the summer period in the sector. Further down in Sector III, the reading was 16 cm and in Sector IV where there was no sand extraction, it was 18 cm.

The velocity of the water current was highest during the monsoon. In the canal of Sector I the water current was 2.0 km/hr in March 1995, and 1.8 km/hr in the mainstream. For the same period in Sector II it was 1.1 km/hr, in Sector III 1.0 km/hr and 0.7 km/hr in Sector IV where the river is highly silted.

3. **Sand extraction**:

Sand extraction was the major cause of habitat degradation. Large quantities of sand were extracted from the dolphin habitat, mostly from the canal area of Sector I, at the confluence of the canal, and in the area down the bridge (Fig. 2). Good quality sand was available only at a few places along the river. About 100 canoes operated, from a stretch of about 1.50 km, each making 3-4 trips daily. The Assam Government leases out the right of sand extraction to the contractors. Annually about 12,500 MT of sand is taken from the river. The sand extraction has caused silting of the dolphin habitat, smothering of bottom fauna, and lowering of the productivity of the river by blocking the sun-light and preventing photosynthesis. These ecological degradations have a serious impact on the fish production on which dolphins depend for food.

4. **Dolphin population**:

Sector I was a good habitat for the dolphins. The dolphins were invariably found at the confluence of the canal joining the mainstream. Four dolphins were seen in this sector. They were found foraging here, unconcerned with the intense sand removal and fishing activities. The dolphins retreated to deeper areas of Sector II after foraging in the adjacent areas. Though Sector II was highly silted, one or two dolphins were noticed. Calves and adults were observed in the deep trench.

The main dolphin habitat was the deep trench in Sector III. The trench was about 8 m deep with an area of 1000 m^2. Five dolphins comprising of adults, adolescents and calves were seen. The adult female dolphin was characterised by a long curved beak and pale brown colour. The adolescent dolphins were paler in colour. The calves were usually dark brown. Dolphins more than 1.5 m in body length were considered adults, 1.0-1.5 m adolescents and less than 1 m as calves. There were differences in the behaviour between adults and calves. Calves were often seen leaping over the surface of the water while the adults and adolescents surfaced exposing their beak and the melon. Occasionally, the adolescent dolphins exposed two-thirds of their body. On one occasion an adolescent dolphin stood vertically, exposing its beak and head above the surface of the water. The dolphins surfaced at intervals of 20 seconds to 3 minutes. The calves surfaced more frequently than the adults at intervals of 15 to 30 seconds. When the adults surfaced, the 'blowing' sound was very audible, with a spurt of water from the nostrils. When an adult dolphin surfaced near the canoe we could smell its breath which was very similar to that of cows.

Between the years 1992 and 1995, there has been a gradual decline in the dolphin population in the habitat. In 1992 we observed 24 dolphins. This number came down to 17 in 1993, 14 in 1994 and 12 in 1995 (Table 1). The decrease in population was 29% in 1992-1993, 17.6% in 1993-94, 14.3% from 1994-95. The reduction is very high in spite of the recruitment as indicated by the presence of calves. The people in the area do not harm dolphins, but accidental entanglement in gill nets cannot be ruled out. One male dolphin, 1.75 m in length, was found on the banks of the river on 15.10.94 near the village Kukumara, with gill net marking near the melon. In 1992 and 1993, as many as 12 dolphins were seen in Sectors I and II, but in 1995 we observed only 7 dolphins in these sectors.

TABLE 1

DOLPHIN POPULATION IN THE RIVER KULSI

	1992	1993	1994	1995
Calves	5	3	3	2
Adolescents	8	8	7	6
Adults	11	6	4	4
	24	17	14	12

6. **Fishes and fishery of Kulsi dolphin habitat**:

Fishes and fishery of Brahmaputra and its drainage were studied by Motwani *et al.* (1962), Yadav and Sugunan (1992), Yadav and Chandra (1994) and Biswas *et al.* (1995). About 225 species are reported so far from Brahmaputra (Yadav and Sugunan, *Ibid*). During our studies, 49 species of fishes, 4 species of prawns and two species of turtles (*Trionyx hurum* and *T. gangeticus*) were recorded from the Kulsi river. This included the food species of the river dolphin *Chela laubuca, Puntius sophore, P. ticto, Colisa fasciata, Glassogobius giuris, Mastacembalus pancalus, Wallago attu, Ompak* sp, *Bagarius bagarius,* and the prawn *Macrobrachium choprai.*

The traditional fishing gear are cast nets (Fasi jal), current net (gill net), dip nets (Dheki jal), drag nets, stalk net (Ban Jal) and moving cast net (othal jal). About 300-800 kg fishes were caught from the river monthly. *Mastacembalus pancalus, Puntius* spp. *Mytus vittatus, Chela laubuca* and *Macrobrachium choprai* form the main fishery.

DISCUSSION

The river dolphins of Kulsi are the only river dolphin population in the area accessible to observers. Furthermore, the population has survived in spite of degradation of its habitat due to human activities, though in decreased numbers.

Pilleri (1970) observed that in November, 1959 a resident population of river dolphins at the confluence of the rivers Kakdanga and Bhogdoi near Neghereting in Jorhat dist. Assam. But when we visited the river in November 1993, it was highly silted and the dolphin population had become extinct. It is possible that the same fate might fall on the dolphins of Kulsi river if the ecological degradation such as sand extraction is continued. Gill nets are hazardous to the dolphins as many thousand marine dolphins have reportedly been killed in them (United Nations, 1990). Hence operation of gillnets is detrimental to the river dolphins.

Perrin *et al* (1994) observed that a mortality rate of 4% and 5% is not sustainable in *Sousa chinensis* with a population of 2000 in the Indian Ocean coast of South Africa and in *Stenella coeruleoalba* with a population of 1,00,000 in eastern north Atlantic respectively. The reproductive biology of these coastal cetaceans is more or less the same as the Ganges river dolphin. Hence, the annual reduction in the Ganges river dolphin population, which ranged from 14-29% during 1992-1995, cannot be sustainable.

These dolphins are at a higher trophic level and feed mainly on fishes and prawns. Many species of fishes have been reported from the stomach contents of the river dolphin. (Shrestha, 1989, Sinha *et al.* 1993). Many of the food species were found in the Kulsi river also. Any degradation of the ecology of the river will have serious impact on the fishery potential of the river, affecting its capacity to sustain the dolphin population.

Any efforts for the restoration of the river should be directed towards banning or regulating sand extraction, banning the operation of gil lnets and creating awareness among the fishermen. Declaration of the river dolphin habitat as a river dolphin sanctuary under the Indian Wildlife (Protection) Act 1972 will go a long way to protect this population. Planned eco-tourism of 'dolphin sighting tours' will help create awareness. 'The River Dolphin Protection Committees' under the Conservation of Nature Trust, Calicut, has initiated many action plans at the grassroots level to protect the species. The Government of Assam and the Ministry of Environment and Forest, Government of India, New Delhi, have been alerted about the impending danger to this population.

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BEHAVIOUR OF THE WHITEHEADED BABBLER *TURDOIDES AFFINIS* JERDON[1]

V.J. Zacharias[2] and D.N. Mathew[3]

(*With two text-figures*)

Key words: whiteheaded babbler, *Turdoides affinis,* behaviour, home range, sentinel, preening, interaction within groups.

The whiteheaded babbler, *Turdoides affinis,* lives in groups. A group has a large home range within which there is a well defined territory. The species has a well organised sentinel system. Though the sentinel duty was shared by other members of the group, the breeding birds and other older birds acted more often as sentinels and for a longer duration. It is speculated that allopreening in the whiteheaded babbler helps to reduce aggression and promote group integration. This babbler roosts communally. The groups of whiteheaded babblers appear to be organised hierarchically. Calls appear to have a definite function in the species. Clumping, allopreening, sentinel system and the large repertoire of vocalizations may be helpful in consolidating the group and co-ordinating its movements.

Introduction

Babblers of the genus *Turdoides* have a wide distribution in South and West Asia and Africa. They live in groups, defend a common territory and nest co-operatively. Biology of the jungle babbler *Turdoides striatus* was studied by Andrews and Naik (1970) and social behaviour by Gaston (1977). Gaston (1977, 1978) has reviewed all previous literature on the genus *Turdoides.*

From 1974 to 1977 we studied the ecology of the whiteheaded and the jungle babbler, two common sympatric species, resident in Malappuram and Calicut districts, (10° 30'-45' N lat and 75° 40'-50' E long) in Kerala, South India. The aim of this paper is to describe some of the behavioural characteristics of the whiteheaded babbler.

Materials and Methods

The whiteheaded babbler *Turdoides affinis* and the jungle babbler *T. striatus* were observed regularly in an area of 2.27 sq. km of the Calicut University Campus. Nearly 5000 hours were spent in the field. Twenty-three adult whiteheaded babblers and nine jungle babblers were trapped in mistnets and marked with coloured plastic rings. Forty-five whiteheaded babblers and sixteen jungle babblers were ringed as nestlings. Day long observations were carried out on individual groups. For comparison, the rufous babbler *T. subrufus* and the Wynaad laughing thrush *Garrulax delesserti* were observed in Wynaad, Kerala and the large grey babbler *T. malcolmi* in Gundalupet, Karnataka.

Results

The whiteheaded babbler forages in groups of 3-14 birds, progressing slowly by hopping and gliding. Individuals remain within a radius of 25-30 m from the centre of the group. Members of a group move together, share a common foraging area, defend a common territory and roost and nest together. They glide from perch to perch or from a bush or tree to the ground. From the ground they fly to the low lying branches and hop from branch to branch. The birds invariably hop to the tree tops and glide again. The group

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moves together, crisscrossing different parts of their home range. Foraging flocks turn over dead leaves and explore the clumps of grasses, curled up leaves, herbs, holes on the ground, and the crevices in tree trunks.

Home Range and Territory

The whiteheaded babbler has a larger home range with a well defended core area, the territory within which they roost and nest. Home ranges of adjacent groups often overlap (Fig. 1) but territories have established boundaries. The size of the home range varies from 5.3 ha to 9.3 ha (Table 1). However there is no relation between the size of the home range and the size of the group (Table 1).

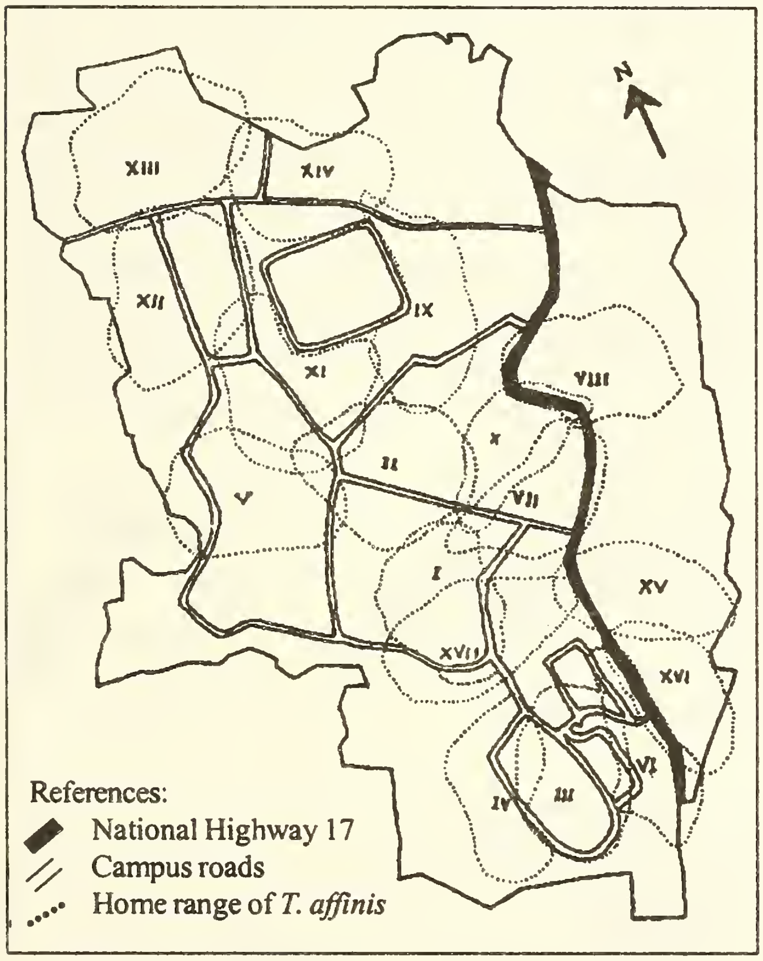

Fig. 1. Home range of *T. affinis* in the Calicut University Campus

The groups are highly territorial and never allow other groups of their own species or jungle babblers to enter into their territory. Trespassers are mobbed by the owners of the territory. Physical clashes occurred in a few cases. However, up to four groups share a common foraging area. They also share common foraging areas with the jungle babbler.

TABLE 1
SIZE OF THE HOME RANGE AND THE GROUP SIZE IN *T. AFFINIS* IN THE CALICUT UNIVERSITY CAMPUS

Group	No. of birds in December 1973	Approx. size of the home range (in ha)
I	5	6.9
II	3	9.3
III	5	7.5
IV	4	6.4
V	14	8.8
VI	10	5.3
VII	4	5.7
VIII	4	7.4
IX	8	8.6
X	6	6.9

Waking Activity and Rest

Whiteheaded babblers wake up between 0555 and 0625 hrs. The first bird to wake up flies out to a new perch followed by others immediately or after waiting for a few minutes. They preen for about 3-6 minutes and start feeding. After feeding for about 30 minutes, the birds preen again for 10-15 minutes before foraging is resumed. From 1330 to 1630 hrs the whiteheaded babbler takes rest in shady areas.

Roosting

At the close of the day between (1800 and 1900 hrs) the whiteheaded babblers noisily assemble on bushes or trees near their feeding sites and preen themselves and one another for 3-18 minutes. The birds rub their bills, call softly and move to their roosting trees. The roosts are 2-6 m high from the ground (Zacharias and Mathew, 1988). In the rainy season, they roam about and halt temporarily on several trees before reaching the final roost. Roosts are changed when the group begin nesting, usually after incubation has begun. On the roosting branch the members of a group sit close to each other. Larger groups roost on more than one branch. Birds reaching late wedge themselves between others. Juveniles roost in the middle of the group.

In March and April we observed 7 cases of some alien adult whiteheaded babblers trying to roost with an established group. These strange birds seemed to be immigrants from areas our outside our study area. When the roosting group was disturbed by any type of commotion in the vicinity, some of the adult birds came out and watched the intruders till the scene became peaceful. In two cases it was the breeding male which came out to scrutinize.

The roosting pattern of the jungle babbler and the rufous babbler is very similar to that of the whiteheaded babbler. But jungle babblers are less noisy at the time of roosting.

Sentinel

In foraging groups of the whiteheaded babbler one bird takes position on a tree or bush and acts as sentinel. Dharmakumarsinhji (1951) described this first in the jungle babbler. Similar behaviour was observed in Florida scrub jay by McGovern and Woolfenden (1989). The sentinel has a clear view of the surroundings. It warns the group of the approaching danger by uttering typical alarm calls. This duty is shared by all members of the group except juveniles, but the breeding birds and other older birds act more often as sentinels and for a longer duration than others (Table 2). In one group, which was observed continuously for about 11 hours, the breeding male spent about 5 hours on sentinel duty. This was observed when the group was not nesting and spent more time feeding. As the day progresses, the time spent on sentinel duty also increases. In the absence of any disturbance, the sentinel watches silently. If a predator or an intruder comes within a distance of 10-15m of a foraging group, the sentinel becomes active and keeps calling, till the danger has passed. A sentinel in action spreads its wings and tail, flicks them fast and keeps on pivoting. As the intruder draws closer to the foraging group, the sentinel hovers over it, and calls loudly and repeatedly (Fig. 2). In a few cases the sentinel flew towards the intruder and attacked it. The first signal of imminent danger is usually given by the sentinel in the form of a screaming "keak" call which is the first part of the alarm call (Table 3) and all the birds in the group respond by taking shelter on

TABLE 2

SENTINEL DUTY OBSERVED IN GROUP I OF THE WHITEHEADED BABBLER FROM OCT - NOV 1976

Status of the Bird	Frequency	Total time spent on duty in minutes
Breeding Male	88	312
Breeding Female	46	98
Non-Breeding Male*	46	102
Non-Breeding Male	32	66
Non-Breeding Bird (sex?)	18	34
Non-Breeding Female	12	30
Second Year Bird	10	21
First Year Bird	6	11
Total Observation	258	694

*Became the breeding male when the breeding male disappeared.

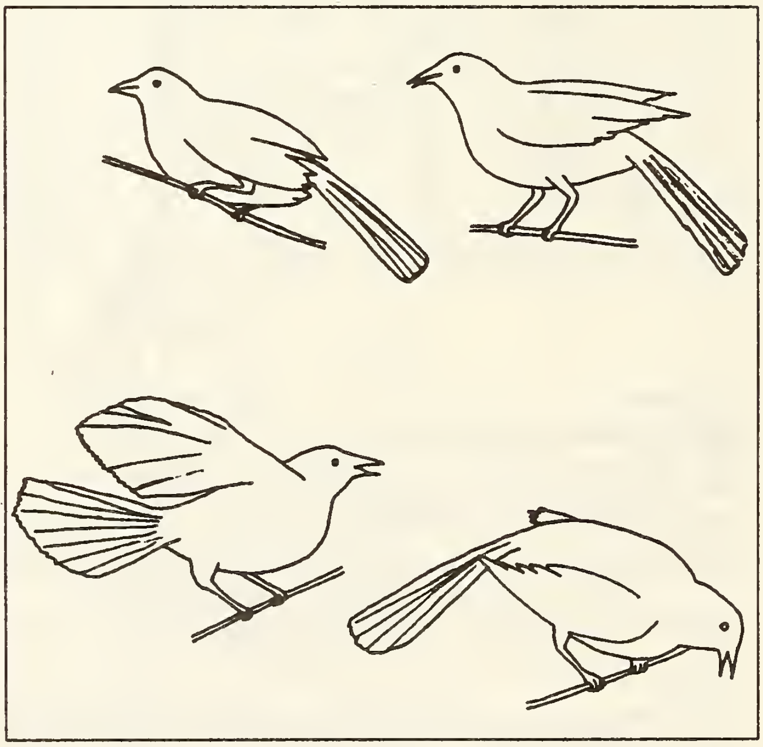

Fig. 2. Poses adopted by a Whiteheaded Babbler on sentinel duty

trees or in bushes. Those on exposed branches and bushes withdraw into more concealed areas. They resume foraging as soon as the predator moves away. But if the intruder persists, the owners of the territory mob it.

The sentinels of *T. affinis* groups move ahead or behind the foraging party. Sometimes the groups appear to feed without a sentinel, at least we could not see one. The moment an intruder appears on the scene, a sentinel moves into position. This sentinel is active only if there is any possibility of danger, otherwise it preens. In larger groups and in those with juveniles, the sentinel on duty is assisted by one or two other birds. The main sentinel carries out its duty as usual. The second and third birds act only for shorter periods.

A sentinel was present in 236 out of 238 observations on *T. affinis.* The sentinel activity was observed at heights of 2-7m on the branches of trees, bushes, rocks, compound walls, lamp posts, sunshades and telephone wires. Changes of sentinels were similar to those of *T. striatus* (Gaston 1977).

In the whiteheaded babbler, the breeding pair normally performed sentinel duty more than the rest of the birds in the group (Table 2). In one group, a non-breeding male Rr was observed

TABLE 3
VOCALIZATIONS OF THE WHITEHEADED BABBLER

Type of call		Description	Context and effect
1. Alarm call	i.	*Keek* call, short & shrill, uttered by by sentinel or any other bird.	Unexpected appearance of a predator/ intruder. Birds take shelter.
	ii.	Low & soft *Kurrh.... Kurrh... Kurrh...* Uttered at low frequency, sounds like winding of time-piece.	If the intruder persisted.
2. Twittering Call		Many syllabled *Ki-Ki Ki-Ki* loudly at high frequency.	Uttered by birds when separated from their group. Nestlings give similar call.
3. Mobbing Call		Loud high pitched whistling call made repeatedly by few or all members of a group. Bills open, wings fluttered.	For driving away predators/intruders and while fighting.
4. Distress Call		Loud whining call resembling the moaning of a young dog when harassed.	Given by young or adult when handled, trapped in nest or hurt in shooting — brings other members of the group to the spot at once.
5. Contact Call		Short low "*Ke*" — uttered at intervals.	Often while foraging and feebly while preening.
6. *Ke-Ke-Ke* Call like the *Cu-Cu-Cu* call of the Jungle Babbler (Gaston 1977)		Low-*Ke-Ke-Ke-* repeated several times.	By adult birds prior to leaving an area.
7. Begging Call		Low pitched whistling call given by older fledglings and juveniles.	Uttered by older fledglings while adults visit the nest and by juveniles while moving with groups.

to act as sentinel for longer duration. The breeding male PB and female G came next in order. In the next nesting, the breeding male PB disappeared and Rr took its place.

On three occasions the sentinel whiteheaded babbler was attacked or chased by the domestic cat, Ceylon shikra *Accipiter badius* and jungle crow *Corvus macrorhyncos,* but suffered no harm.

Interaction within group

Members of a group foraged within close distance and no conflict was observed between them. Juveniles often tried to snatch the prey collected by adult birds. The adults either conceded or moved away.

Response to Predators and Other Alien Species

The whiteheaded babblers often foraged together with the jungle babblers, crows, mynas, drongos and squirrels without any conflict. But clashes were observed between individual whiteheaded babblers and common mynas and babblers and black drongos over insect food.

These babblers never tolerated birds of prey like kites, hawks, owls and owlets and ground predators like mongooses and snakes near their territory, or foraging areas. Babblers are aggressive towards these predators and mob them and never rest until the intruders move away. But if the intruders persist, the babblers withdraw to a safe area.

Preening and Body Care

In the intervals between feeding, the whiteheaded babblers very often clumped together. In clumping the birds pressed their bodies close together. Clumping was invariably accompanied by allopreening. The birds often perched facing in same or opposite directions for allopreening. Some individuals moved a little away and indulged in autopreening. Soliciting of allopreening is commonly observed, mostly among juveniles and first year birds. The bird to be preened sidled towards another bird as if to solicit attention. The former then dropped its wings, raised its head, erected the feathers on the head and neck and got closer to the prospective preener. The latter also raised itself by stretching its legs and preened different parts of the head and body of its partner.

Three or four birds sometimes formed allopreening units. The breeding pair spent more time in allopreening. Allopreening interaction started at waking time and could be observed during different times of the day. Longer bouts of allopreening occurred from 0630 to 0830 hrs and from 1300 to 1500 hrs. Similar allopreening was observed in the jungle babbler and the Wynaad laughing thrush. It was also recorded in the jungle babbler and the common babbler *T. caudatus* by Gaston (1977, 1978).

Hardy (1974) described the feather erection behaviour in the head and neck region as forming the typical submission posture among neotropical jays of the genus *Cissilopha* as an invitation for allopreening. According to Gaston (1977) in the jungle babbler, soliciting, and receiving allopreening help to maintain an individual's position within its group, reduce aggression and promote group cohesion.

Leadership in Movements

On a few occasions when the whiteheaded babblers crossed open areas like playgrounds and roads or attacked intruders we could identify the leading bird. Out of 21 such cases (group I, during 1975-76), the breeding male proceeded first in 9, the breeding female in 4 and a nonbreeding male in 6 cases.

Play Among Birds

First year whiteheaded babblers indulged in 2 types of behaviour which could be described as play.

1. Chasing each other

The first year whiteheaded babblers chased one another from perch to perch on trees and also on ground without any apparent provocation. This type of behaviour was observed in the first year jungle babbler, rufous babbler, large grey babbler and the Wynaad laughing thrush. Gaston (1977, 1978) has observed this in the jungle babbler and the common babbler.

2. Leap-frogging behaviour

Two or more first year birds moving on the ground ran one after the other with drooped wings. They pecked each other and occassionally one young whiteheaded babbler leaped over the head of another.

Bathing

In the course of their foraging activities whiteheaded babblers bathed in canals and ditches. One by one the birds hopped into the water, dipped their heads and underparts and wings of each side alternately.

The babblers then moved to perches and shook themselves vigorously for a while and then splashed into the water again. This was repeated 3 or 4 times, and thereafter the birds dried their feathers and preened. This behaviour was observed in the jungle babbler, the rufous babbler, and the Wynaad laughing thrush. On one occasion these babblers were observed bathing with jungle babblers, magpie robin, common myna and tree pie in a small spring.

Sunbathing

Both jungle babblers and whiteheaded babblers sometimes exposed themselves to the bright warm sun, stretched their body and wings and preened. This activity appears to be sunbathing.

Vocalization

Seven types of calls were distinguished (Table 3) in the whiteheaded babbler. The calls appeared to have definite functions like warning and co-ordination of movements of the group. Andrews and Naik (1970) listed seven and Gaston (1977), eleven types of vocalization in the jungle babbler.

Discussion

In our study area, the whiteheaded babbler and the jungle babbler live sympatrically. There is a great deal of similarity in their behaviour patterns. The whiteheaded babbler has a large home range with a well defended core area, the territory. Allopreening is likely to reduce aggression and promote group integration in the species. The sentinel system is important in ensuring the survival of the whiteheaded babbler. It is noteworthy that the more mature birds like the breeding pair which could be expected to have a better knowledge of the group's home range served for longer periods as sentinels. Gaston (1977) has suggested that the sentinel birds of the jungle babblers were able to forgo foraging for longer duration and that this behaviour may be related to the birds' superior ability to find food. Gaston (op. cit) has also indicated that the role of sentinel may be partly to advertise the status of the birds concerned. Self advertisement relating to the dominance status was described by Moholt and Trost (1989) in blackbilled magpie. The sentinel of *T. affinis* often detected the conspecific intruders from the territory. It may also be possible to attribute a territorial display for the sentinel behaviour. Since the sentinel often flies towards the intruders and attacks them, it takes the risk of predator attack, which indicates an altruistic function. Several factors listed below point to the possibility that this species has a well established hierarchical organization.

1. Playful fights of juveniles may be a means of establishing their position in the hierarchical order of the group.

2. The older birds and breeding pair spend a lot of time in allopreening.
3. The breeding birds and other older birds serve longer spells as sentinels.
4. In an exceptional case where a non-breeding adult male was the first sentinel, it became the breeding male, when the breeding male of the group disappeared.
5. In a few cases observed, the breeding male was the first to move out after waking and while the group crossed an open field or playground.

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POPULATION DYNAMICS OF A FEW DOMINANT PLANT SPECIES AROUND INDUSTRIAL COMPLEXES, IN WEST BENGAL, INDIA[1]

AMAL KUMAR SAHU[2] AND SAURIS PANDA[3]

Key words: Population dynamics, pollutants, industrial complexes, *Clerodendrum viscosum, Lantana camara* var. *aculeata, Croton bonplandianum, Chromolaena odorata*

The paper deals with the population dynamics of four plant species, namely *Croton bonplandianum* Baill., *Clerodendrum viscosum* Vent., *Chromolaena odorata* (L.) King & Robinson and *Lantana camara* L. var. *aculeata* (L.) Moldenke in the vicinity of two industrial complexes at Kuntighat and Rishra in West Bengal, India. Of the four plant species, the former two were studied at Kuntighat and the latter two at Rishra. *Croton bonplandianum* and *Clerodendrum viscosum* showed higher flux rate than the others. Though all the species except, *Lantana camara,* showed high mortality rate, they produced large numbers of plants for survival. The aggressive nature of these species was noteworthy, in spite of the pronounced effect of pollutants.

INTRODUCTION

The study of vegetation in the vicinity of industrial complexes has provided excellent data indicating the response of plant population to environmental pollution (Porter, 1926; Little and Martin, 1972; Jordan, 1975). It has also revealed the capabilities of plant a species to fit into a changing environment, at the same time improving its chances of survival. Gemmell (1975) gave information concerning the plant population around an iron-smelting plant. Only grasses were able to survive in that area. Rosenberg *et al.* (1979) have studied the plant species composition at varying distances along the pollution gradient. They concluded that the wastes from industrial complexes were important in explaining the variations in plant population. Various changes may occur in soil due to continuous addition of wastes like carbon and sulphur particles, ash, heavy metals and soluble salts. The changed parameters are metal toxicity, acidity, alkalinity and non-availability of nutrients (Gemmell, 1973; Ragaini *et al.,* 1977). These can hamper the normal growth and distribution of plants. Again, soil nutrient status, rainfall, temperature and exposure to polluted environment certainly have an impact on species distribution (Hodgson and Townsend, 1973). The distribution pattern of a plant species is dependent on the interspecific and/or intraspecific interactions (Shimwell, 1971). Plant-animal interaction also controls the population size. Continuous influx of species from nearby vegetation causes the variation in plant populations. Only species having competitive reproductive abilities can survive and reproduce well in polluted habitats, others are annihilated.

In India, only a few researchers have studied the qualitative ecological aspects of flora around industrial complexes (Sreerangaswamy *et al.* 1973; Pathmanabhan *et al.* 1979). Sketchy work has been done on plant population dynamics in and around industrial centres. Sahu and Santra (1986, 1988, 1989) however, reported the ecological, morpho-anatomical and biochemical aspects of various plant species at these sites.

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The present objectives include (1) investigation of plant population flux rate, annual mortality rate, tolerance capacity and survival ability, and (2) the documentation of plant species population response to industrial pollution, which could be used for restoration, and biomonitoring of healthy environment around industrial establishments.

MATERIAL AND METHODS

A. **Study sites**

The study areas — Kuntighat and Rishra, located in southern West Bengal, India, have an average 6 m elevation. Both are already marked as polluted habitats (Sahu and Santra, 1989). The nature of waste discharges is different in these two stressed habitats (Table 1).

TABLE 1

STUDY SITES WITH WASTES AND SOURCE

Industrial Centre	Waste source	Wastes
Kuntighat (long 88° 35' E lat 20° 19' N)	Rayon complex, H_2SO_4 plant, CS_2-plant, Paper mills, Textile mills, etc.	SO_2, H_2S, CS_2, heavy metal, H_2SO_4 vapour and carbon dust.
Rishra (long 88° 30' E lat 20° 19' N)	Alkali chemical, Pharmaceuticals, Crop protecting chemical factory, Metallurgical works, etc.	H_2S, NaOH dust, NH_3, Cl_2, organo-phosphate chemicals, Hg and fluorides.

There are little fluctuations in temperature, rainfall, relative humidity and sunshine. Soil types are sandy-loam at Kuntighat and loamy-sand at Rishra, but the pH value of the soil differed (Kuntighat: pH 4.3-4.6; Rishra: pH 6.5-7.7) as reported earlier by Sahu (1990).

B. **Methods**

Quantitative sampling of species was based on their dominance pattern at the study sites. Only four species were taken into consideration. Population dynamics were calculated according to Bharadwaj and Gopal (1978). Three permanent plots (5 m x 2 m) were taken for a period of one year. Observations were made every month and plants were tagged with plastic coated copper wire at the base of each plant.

RESULTS

The population dynamics of four taxa, namely *Croton bonplandianum* and *Clerodendrum viscosum* of Kuntighat, *Chromolaena odorata* and *Lantana camara* of Rishra, were investigated round the year. The data on various parameters were the average value of three permanent plots (10 m^2) and are depicted in Table 2.

The most common species at Kuntighat industrial complex were *Croton bonplandianum* and *Clerodendrum viscosum.* The initial and final plant density was higher in *Croton bonplandianum* than in *Clerodendrum viscosum.* But nett change, rate of change and percentage of gain was higher in *Clerodendum viscosum.* In both the cases, the total number of individuals recruited and lost throughout the year was almost the same, although the total number of individuals recorded was higher in *Croton bonplandianum.* Annual mortality rate was found to be higher in both the cases.

At the Rishra industrial complex area, two species, namely *Chromolaena odorata* and *Lantana camara* showed very low density at the starting (9-10 individuals/10 m^2) and also at the end of the experiment (12 individuals/10 m^2). Thus the nett change, rate of change and percentage of gain were also low. But survival ability of these species was higher. The number of individuals recruited, recorded and lost was noteworthy, being always higher in *Chromolaena odorata.* Annual mortality rate was low in *Lantana camara.*

DISCUSSION

Industrial complexes produce various types of pollutants during operations. They release wastes in the form of particles or gases. The latter

TABLE 2
POPULATION DYNAMICS OF FOUR SPECIES AT KUNTIGHAT AND RISHRA INDUSTRIAL COMPLEXES

	Parameters	Values*			
		K-Cb	K-Cv	R-Co	R-Lc
(a)	Number of individuals/10 m^2 at the beginning of the year	36	12	10	9
(b)	Number of individuals/10 m^2 at the end of the year	42	19	12	12
(c)	Nett change (b-a)	+6	+7	+2	+3
(d)	Rate of change (b/a)	1.16	1.58	1.20	1.33
(e)	Gain (%) (c/a x 100)	16.67	58.33	20.00	33.33
(f)	Number of individuals recruited throughout the year	69	63	26	8
(g)	Number of individuals still survive (out of a)	8	3	7	6
(h)	Number of individuals lost (out of a)	28	9	3	3
(i)	Total plants recorded (a+f)	105	75	36	17
(j)	Total plants lost (i-b)	63	56	24	5
(k)	Annual mortality (%) (j/i x 100)	60.00	74.67	66.67	29.41

K-Cb — *Croton bonplandianum* & K-Cv — *Clerodendrum viscosum* of Kuntighat; R-Co - *Chromolaena odorata* & R-Lc - *Lantana camara* var. *aculeata* of Rishra

* Each value is the average of three permanent plots ($10m^2$) 75 m apart from the complexes.

are sometimes condensed to form non-volatile products. Pollutants spread around the source are deposited on soil or plant surfaces according to the mass of particles, wind direction, nature of interception, humidity, rainfall, etc. Some amount of gaseous pollutants can be absorbed by soil (Smith *et al.*, 1973). Plant surface acts as a secondary source of pollution, as the deposited products are later transferred to the soil surface by rainfall, fog, etc. The pollutants later intermix with soil, changing its nature and eventually controlling seed germination, seedling establishment, plant distribution pattern, biodiversity, dominance pattern, etc.

The study of plant population in the vicinity of industrial complexes is of great importance. The total number of species occurring in a particular area were found to be influenced both by natural phenomena and pollution. A large number of taxa were recorded in the study areas in the monsoon, due to water holding capacity of soil, seed viability, seed germination ability, in spite of the continuous addition of toxic pollutants. This is probably due to draining out of waste from the soil surface before it has been sufficiently absorbed in soil. Later, during the dry season, the number of plants recruited were less, due to higher toxicity which caused the death of some plants. Acidity and alkalinity of the soil also play an important role in determining the plant density in an area (Little and Martin, 1972).

Annual mortality rate of the relevant species was higher at both the sites. Mortality at the seedling stage was highly affected by intraspecific competition (Shimwell, 1971). The soil pH is one of the factors determining the distribution of species. Plant species vary with regard to their optimum pH requirement. At Kuntighat soil pH is highly acidic, probably resulting in high mortality rate of plants. Soil at Rishra was nearly neutral to slightly alkaline. *Lantana camara* thrives best in this habitat, while *Chromolaena odorata* fails to do so. For this reason, probably, the former showed lower annual mortality than the latter, although other factors were also involved.

Our study revealed that low survival of a species reflects different aspects of its reproductive biology, e.g. low seed viability, low food storage in seed and other external factors, e.g., soil moisture content, pH of soil and pollutant concentration within its limit.

An analysis of the impact of industrial pollutants on population flux explained that species population responded well to the environment. All taxa showed high flux rate, high mortality rate and degree of aggressiveness. It is assessed that *Croton bonplandianum. Clerodendrum viscosum* and *Chromolaena odorata* showed an aggressive nature. Further, these plants possessed a high capacity of pollen production, pollen germination, fertility rate, seed production, seed viability and seed germination (Harper *et al.*, 1970; Karnosky and Stairs, 1974). *Lantana camara* is a tolerant species and showed low recruitment. This is due to low fertility rate and in part due to aborted maturation of fruit (Baron, 1984).

These species may help in monitoring environmental pollution and reclamation. They may provide useful data demonstrating the degree of response to environmental deterioration.

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SIGNIFICANCE OF BIOMETRIC RATIOS AND BIOACOUSTIC ANALYSIS IN AMPHIBIAN SYSTEMATICS[1]

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(*With one text-figure and one plate*)

Key words: Amphibia, systematics, morphometric measurement, biometric ratio, bioacoustic analysis

Out of the listed 4522 amphibian species of the world, 56 species are reported from the northeastern region of India. These reports are based on the morphological characters. In recent years, bioacoustic analysis of species-specific mating calls of frogs are shown to have important relevance to amphibian systematics. The question that arises now is, whether mere deviation in call pattern should be the basis for new species identification or should there also be an attempt to correlate call differences with differences in morphological characters?

The works of Kauri (1959), Berger (1966) and Tinsley (1973, 1975) gave an insight to this problem. These works showed that absolute measurements of body parts may vary but their ratios remain almost constant between individuals within the same species. Thus, when an intraspecific call variation is recorded, the biometric ratios of the individuals that differ in call pattern should also be worked out. If both the call pattern as well as the biometric ratios vary from the known records, only then should it be recorded as a new species.

The present report constitutes the first detailed account of Indian amphibians describing the call pattern in terms of temporal and spectral characters, absolute measurements and biometric ratios for 10 species from northeast India, which are of obvious utility for any future systematic work on Indian amphibians.

INTRODUCTION

With its wide range of variation in climate, geography and topography, the Indian subcontinent has a rich faunal distribution. The distribution of amphibians is very uneven across India, with the highest concentration in the northeast and the western ghats of the West Peninsular region. Because of its dense tropical forests, varying altitudinal gradients and relatively little ecological disturbance, the northeastern region shows richness and diversity of Indian amphibian species. Out of the listed 4522 amphibian species (WWF, 1994) of the world, 207 are found in India of which 56 have so far been reported from the northeastern region (BCPP CAMP Report 1997). Yet the northeastern region remains unattractive for field research, probably due to its difficult terrain. The amphibia therefore, are incompletely known and require extensive survey.

The existing faunal record of 56 amphibian species from the northeast is based on morphological characters (Pillai and Chanda 1976, Chanda 1994). Recent work from India (Roy and Elepfandt 1993, Roy 1994, Roy *et al.* 1995) and abroad (Ryan 1985, 1986; Schneider and Sinsch 1992; Sinsch and Schneider 1996) has demonstrated that anuran mating calls constitute an important character for species identification,

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more distinctive than morphological characters. Roy and Elepfandt (1993) recorded three different advertisement calls from frogs, all of which were identified morphologically as *Rana limnocharis,* currently known as *Limnonectes limnocharis.* These differences suggest that the so called *R. limnocharis* in northeast India is not one species but a composition of several species of similar morphological appearance. Similar results have been reported by Sarma (1996). These results clearly suggest the necessity of re-examining *R. limnocharis* from the northeast with biometric and bioacoustic studies. It is interesting to note that in Nepal, which neighbours northeast India, the previous *R. limnocharis* (= *Limnonectes limnocharis*) has been subdivided into 4 species, namely *R. limnocharis* proper, *R. sahyadrensis, R. nepalensis* and *R. pierrei*, all of them belonging to one *R. limnocharis* group (Dubois 1975). Their separation has been done on the basis of the species mating call. Among recent examples are the yellow-bellied toad in northern Greece consisting of several subspecies of *Bufo variegata* (Vasara *et al.* 1991), European lake frog *Rana ridibunda* (Schneider and Sinsch 1992), the water frogs of Greece (Schneider *et al.* 1993) and pool frogs of Europe *Rana lessonae* (Sinsch and Schneider 1996).

The question now is whether mere deviation of the call pattern should be the basis for species identification or should there also be an attempt to correlate call differences with differences in morphological characters. The works of Kauri (1959), Berger (1966) and Tinsley (1973, 1975) give an insight into this problem. Tinsley (1973, 1975) showed that whereas absolute measurements of body parts may vary, their ratios remain almost constant between individuals within the same species. The ratios vary depending upon ecological interactions which may account for their adaptation and change in behavioural pattern in different ecological niches. Thus, when an intraspecific call variation is recorded, the biometric ratios of the individuals that differ in call pattern should also be worked out. If both the call pattern and the biometric ratios vary from the known records, only then should the specimen be recorded as a new species.

With this in mind, survey was taken up during the breeding season of the amphibians for 2 consecutive years 1994 and 1995 in northeast India. This is the first detailed account, describing absolute measurements, biometric ratios and call pattern in terms of temporal and spectral characters of 10 Indian amphibian species namely — *Limnonectes limnocharis*, *Limnonectes khasiana*, *Hyla annectens, Polypedates maculatus, Euphlyctis cyanophlyctis, Rana alticola, Polypedates leucomystax, Amolops formosus, Bufo melanostictus* and *Hoplobatrachus tigerinus.*

The present work also gives detailed descriptions of colour patterns of live specimens. Early descriptions on coloration of frogs from northeast India are based on preserved specimens. As a result, sometimes the colour descriptions of preserved specimens do not match with the coloration of live specimens, e.g., *Hyla annectens* was reported to be dark grey to slate coloured (Chanda 1994) but our observation of live *Hyla annectens* shows that they are dorsally very bright green. Correct description of coloration is also of great significance in amphibian taxonomy (Nussbaum and Sheng 1995).

MATERIALS AND METHODS

Survey, call recordings and collections were carried out in Assam and Meghalaya during the breeding period from May to August in two consecutive years, 1994 and 1995. Field recordings and collections were made daily from around 1800 hrs sometimes until midnight. Large numbers were observed on days with cloud cover or moderate rainfall in comparison to dry, hot days and days with heavy rainfall.

The calls were recorded on a professional SONY WM-6DC cassette recorder with an unidirectional AKG C451EB shotgun condenser microphone held approximately 40-60 cm away from the calling frog. The calls were stored on Maxell XLII cassette tapes. Sound pressure level was measured by playing back isolated calls on a Philips double cassette player DR920 with playback volume fixed at volume 3 and the CYGNET 2021 sound pressure level held approximately 1 m away from the sound source.

Recorded acoustic stimuli were digitized via a Microsoft analogue to digital interface board onto an IBM PC and stored on diskettes. Oscillograms shown as waveform display of amplitude versus time trace; sonogram as the frequency versus time trace with amplitude represented by shades of grey and mean spectra showing the maximum energy concentration at a particular frequency band were prepared with a computerised Fast Fourier Transformation (FFT) system after passing through band pass filters.

Measurements of the following 15 absolute morphometric characters were recorded from atleast 5 or more individuals each of males and females separately from each of the 10 species studied, except for *Limnonectes khasiana*, where only 3 males were found and no females were found. From the morphometric measurements 8 biometric ratios were worked out. All measurements were accurate to 0.1 mm.

A. MORPHOMETRIC CHARACTERS

1.	Body length:	Snout to vent length (SVL)
2.	Body width:	Measured at the widest part across the abdomen
3.	Head width (min.):	At the tip of the snout parallel to the nostril
4.	Head width (max):	Measured at the widest part across the eyes
5.	Snout length:	Perpendicular distance from below the nostril to the tip of the mouth
6.	Eye diameter:	Transverse distance across the exposed orbits.
7.	Interocular distance:	Transverse distance between inner bases of the circum-orbital plaques
8.	Nostril diameter:	Measured across the long axis of the nostril
9.	Internarial distance:	Distance between inner margin of the nostril bordering flaps
10.	Hindlimb length:	Vent to tip of the 5th toe
11.	Tibia length:	Medial measurement of the outer ventral surface of the digit
12.	4th toe length:	Measurement of the outer ventral surface of the digit
13.	Total forelimb length:	Origin of the limb to the tip of the 1st finger
14.	Lower forelimb length:	Outer angle of the elbow to the tip of the 1st finger
15.	Ist finger length:	Base to the tip of the 1st finger

B. BIOMETRIC RATIOS

1. Head width (Min) / Head width (Max)
2. Snout length / Head width (Min)
3. Eye diameter / Interocular distance
4. Nostril diameter / Internarial distance
5. Tibia length / 4th toe length
6. 1st finger length / Lower forelimb length
7. Total forelimb length / Body length
8. Body length / Hindlimb length

C. CALL CHARACTERS

1.	Call duration (sec):	Duration from the beginning of a call to its end

TABLE 1

ABSOLUTE MEASUREMENTS (IN CMS) OF 15 MORPHOMETRIC CHARACTERS OF *LIMNONECTES LIMNOCHARIS, LIMNONECTES KHASIANA, HYLA ANNECTENS, POLYPEDATES MACULATUS, EUPHLYCTIS CYANOPHLYCTIS, RANA ALTICOLA, POLYPEDATES LEUCOMYSTAX, AMOLOPS FORMOSUS, BUFO MELANOSTICTUS, HOPLOBATRACHUS TIGERINUS*

Characters	*L. limnocharis*		*L. khasiana*	*H. annectens*		*P. maculatus*		*E. cyanophlyctis*	
	Male	Female	Male	Male	Female	Male	Female	Male	Female
Body length	4.11 ± 0.36	4.75 ± 0.36	3.50 ± 0.05	3.82 ±0.17	4.83 ± 0.23	4.14 ± 0.17	4.56 ± 0.27	3.90 ± 0.32	3.40 ± 0.66
Body width	2.11 ± 0.37	2.50 ± 0.21	2.40 ± 0.10	1.37 ± 0.04	1.93 ± 0.18	1.80 ± 0.08	1.80 ± 0.10	1.60 ± 0.04	1.40 ± 0.32
Head width (Min)	0.96 ± 0.10	1.12 ± 0.04	0.65 ± 0.05	0.67 ± 0.04	0.80 ± 0.14	0.96 ± 0.08	1.02 ± 0.04	0.90 ± 0.18	0.70 ± 0.18
Head width (Max)	1.50 ± 0.13	1.70 ± 0.07	1.80 ± 0.10	1.12 ± 0.08	1.50 ± 0.00	1.50 ± 0.06	1.58 ± 0.11	1.30 ± 0.00	1.10 ± 0.19
Snout length	0.70 ± 0.08	0.75 ± 0.05	0.45 ± 0.50	0.52 ± 0.08	0.70 ± 0.00	0.68 ± 0.04	0.76 ± 0.08	0.63 ± 0.04	0.58 ± 0.09
Eye diam.	0.48 ± 0.05	0.50 ± 0.07	0.45 ± 0.50	0.47 ± 0.12	0.56 ± 0.04	0.56 ± 0.04	0.61 ± 0.04	0.53 ± 0.04	0.47 ± 0.08

2.	Call period (sec):	Duration from the beginning of a call to the beginning of the next call
3.	Pulse number:	The number of individual components of each call (FFT length - 256; Overlap-50%; Window - Hamming)
4.	Dominant frequency (kHz):	The frequency with maximum intensity
5.	Frequency domain (kHz):	The range of frequencies that differ by less than 10dB intensity from the dominant frequency.

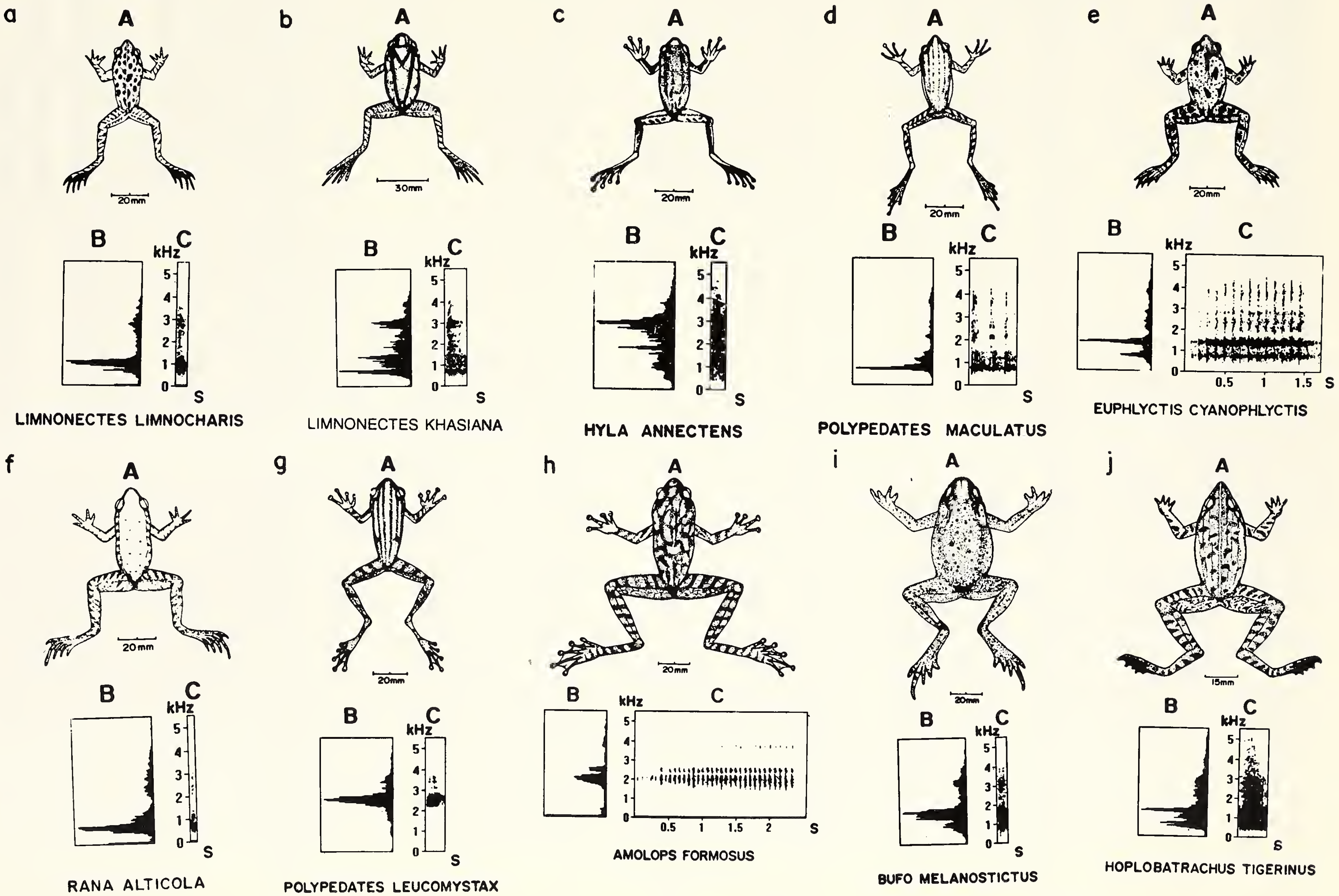
After noting down the morphometric measurements and recording the calls, a few specimens from each species were preserved in 8% formaldehyde for photography and drawing and the rest were released in their natural habitat.

OBSERVATIONS

15 absolute measurements (Table 1); 8 biometric ratios (Table 2) and temporal and spectral data after acoustic analysis of the mating calls (Table 3) of 10 anuran species from northeast India have been compiled. In Plate 1 'A' represents the line drawings for the different frog species (to scale); 'B' shows the mean spectra of the mating calls and 'C' the corresponding sonogram (FFT length: 265; Overlap: 50%, Window: Hamming). Fig. 2 shows the waveform representation or oscillogram of a single call for each of these 10 species.

Limnonectes limnocharis (Plate 1a. A, B, C & Fig. 1a; Tables 1, 2 & 3)

1. **Habit and Habitat**: Known as the cricket frog, it is generally found in shallow marshes, damp grassland near canals and ditches and in flooded fields during the rainy season. Before and during the breeding period they hide



LIMNONECTES LIMNOCHARIS

LIMNONECTES KHASIANA

HYLA ANNECTENS

POLYPEDATES MACULATUS

EUPHLYCTIS CYANOPHLYCTIS

RANA ALTICOLA

POLYPEDATES LEUCOMYSTAX

AMOLOPS FORMOSUS

BUFO MELANOSTICTUS

HOPLOBATRACHUS TIGERINUS

A: Line drawings of different species to scale; B: Mean spectrum of mating call of the corresponding species; C: Corresponding sonogram (FFT length - 256, Overlap 50% Window - Hamming)

Table 1 *(contd)*

ABSOLUTE MEASUREMENTS OF 15 MORPHOMETRIC CHARACTERS OF *LIMNONECTES LIMNOCHARIS, LIMNONECTES KHASIANA, HYLA ANNECTENS, POLYPEDATES MACULATUS, EUPHLYCTIS CYANOPHLYCTIS, RANA ALTICOLA, POLYPEDATES LEUCOMYSTAX, AMOLOPS FORMOSUS, BUFO MELANOSTICTUS, HOPLOBATRACHUS TIGERINUS*

Characters	*L. limnocharis*		*L. khasiana*	*H. annectens*		*P. maculatus*		*E. cyanophlyctis*	
	Male	Female	Male	Male	Female	Male	Female	Male	Female
Inter ocular distance	0.33 ± 0.11	0.40 ± 0.07	0.35 ± 0.50	0.50 ± 0.00	0.73 ± 0.04	0.52 ± 0.07	0.55 ± 0.07	0.43 ± 0.04	0.35 ± 0.07
Nostril diam.	0.20 ± 0.00	0.20 ± 0.00	0.10 ± 0.00	0.17 ± 0.04	0.20 ± 0.00	0.12 ± 0.04	0.10 ± 0.00	0.23 ± 0.04	0.22 ± 0.04
Inter narial distance	0.46 ± 0.04	0.40 ± 0.04	0.70 ± 0.00	0.30 ± 0.00	0.40 ± 0.00	0.30 ± 0.00	0.36 ± 0.08	0.33 ± 0.04	0.32 ± 0.04
Hind limb length	6.48 ± 0.57	7.62 ± 0.45	5.30 ± 0.10	5.70 ± 0.12	7.83 ± 0.47	6.52 ± 0.21	7.12 ± 0.69	5.80 ± 0.28	5.10 ± 0.81
Tibia length	1.75 ± 0.21	2.17 ± 0.12	2.40 ± 0.10	1.70 ± 0.12	2.20 ± 0.16	2.12 ± 0.16	2.34 ± 0.24	1.70 ± 0.04	1.50 ± 0.21
Fourth toe length	1.82 ± 0.10	2.37 ± 0.23	1.20 ± 0.10	1.70 ± 0.12	2.30 ± 0.14	1.92 ± 0.07	1.98 ± 0.21	1.90 ± 0.09	1.70 ± 0.35
Total fore limb length	1.51 ± 0.30	2.12 ± 0.12	2.10 ± 0.10	2.72 ± 0.08	3.40 ± 0.14	2.80 ± 0.10	2.92 ± 0.27	1.80 ± 0.04	1.60 ± 0.28
Lower fore limb length	1.33 ± 0.21	1.42 ± 0.14	1.30 ± 0.10	2.03 ± 0.16	2.53 ± 0.23	2.02 ± 0.29	2.16 ± 0.28	1.40 ± 0.00	1.00 ± 0.27
First finger length	0..61 ± 0.09	0.70 ± 0.07	0.45 ± 0.05	0.45 ± 0.05	0.53 ± 0.04	0.66 ± 0.04	1.90 ± 0.24	1.76 ± 0.09	0.60 ± 0.15

themselves among vegetation and under stones. They are good jumpers, when disturbed escape into dense vegetation and water. They do not remain in deep water for long but swim back immediately to the bank.

2. **Coloration** (Plate 1a.A): Dorsal surface grey with black spots; a wide whitish median line; ventral surface white or creamish; throat grey, sometimes black granulate.

3. **Morphometric measurements and biometric ratios** (Tables 1 & 2): Absolute measurements of 15 morphometric characters and 8 biometric ratios were recorded from 10 males and 10 females respectively.

4. **Call characteristics** (Plate 1a. BC & Fig. 1a; Table 3): The calls are given in rapid succession. Each call lasts about 0.11 seconds with 56 pulses, given at intervals of approximately 0.252 seconds. The call has a single dominant frequency at about 1.08 kHz, extending from 0.35 kHz to 4.40 kHz. The sound pressure level (SPL) of the call is 68.1dB.

TABLE 1 *(contd.)*

ABSOLUTE MEASUREMENTS (IN CMS) OF 15 MORPHOMETRIC CHARACTERS OF *LIMNONECTES LIMNOCHARIS, LIMNONECTES KHASIANA, HYLA ANNECTENS, POLYPEDATES MACULATUS, EUPHLYCTIS CYANOPHLYCTIS, RANA ALTICOLA, POLYPEDATES LEUCOMYSTAX, AMOLOPS FORMOSUS, BUFO MELANOSTICTUS, HOPLOBATRACHUS TIGERINUS*

Characters	*R. alticola*		*P. leucomystax*		*A. formosus*		*B. melanostictus*	*H. tigerinus*
	Male	Female	Male	Female	Male	Female	Male	Male
Body length	5.10 ± 0.08	5.45 ± 0.05	5.40 ± 0.18	8.40 ± 0.26	4.43 ± 0.13	8.20 ± 1.03	7.80 ± 0.20	14.33 ± 4.18
Body width	1.33 ± 0.12	1.65 ± 0.05	1.60 ± 0.22	2.63 ± 0.16	2.20 ± 0.08	3.58 ± 0.36	3.90 ± 0.08	5.16 ± 0.84
Head width (Min)	0.96 ± 0.09	1.15 ± 0.05	1.20 ± 0.11	1.80 ± 0.04	1.20 ± 0.08	1.82 ± 0.09	1.60 ± 0.12	3.60 ± 0.14
Head width (Max)	1.46 ± 0.16	1.75 ± 0.05	1.90± 0.09	2.70 ± 0.04	1.80 ± 0.08	2.60 ± 0.42	2.90 ± 0.08	4.40 ± 0.29
Snout length	0.86 ± 0.09	0.08 ± 0.00	0.97 ± 0.08	1.30 ± 0.04	0.86 ± 0.04	1.18 ± 0.16	1.10 ± 0.05	1.90 ± 0.12
Eye diameter	0.66 ± 0.04	0.65 ± 0.05	0.68 ± 0.03	0.80 ± 0.00	0.86 ± 0.04	0.81 ± 0.39	0.10 ± 0.005	1.70 ± 0.08
Inter ocular distance	0.50 ± 0.00	0.45 ± 0.05	0.78 ± 0.11	1.10 ± 0.00	0.46 ± 0.04	0.76 ± 0.12	0.65 ± 0.05	1.10 ± 0.04
Nostril diameter	0.20 ± 0.00	0.20 ± 0.00	0.10 ± 0.00	0.16 ± 0.02	0.20 ± 0.00	0.22 ± 0.04	0.30 ± 0.00	0.23 ± 0.04
Inter narial distance	0.50 ± 0.08	0.55 ± 0.05	0.41 ± 0.03	0.70 ± 0.00	0.56 ± 0.04	0.83 ± 0.21	0.50 ± 0.00	0.63 ± 0.04
Hind limb length	7.30 ± 0.07	7.60 ± 0.10	8.35 ± 0.16	11.90 ± 0.32	8.66 ± 0.13	13.74 ± 1.33	9.90 ± 0.30	20.70 ± 2.56
Tibia length	2.20 ± 0.08	2.45 ± 0.05	2.77 ± 0.26	3.76 ± 0.20	3.04 ± 0.04	4.66 ± 0.22	2.60 ± 0.12	5.40 ± 0.28
Fourth toe length	2.06 ± 0.09	2.25 ± 0.05	2.28 ± 0.21	2.93 ± 0.30	2.32 ± 0.09	3.74 ± 0.17	2.70 ± 0.12	5.30 ± 0.49
Total fore limb length	2.90 ± 0.21	2.65 ± 0.05	3.45 ± 0.04	5.23 ± 0.20	3.16 ± 0.04	4.84 ± 0.67	5.00 ± 0.05	6.60 ± 0.41
Lower fore limb length	1.76 ± 0.16	1.65 ± 0.05	2.40 ± 0.15	3.80 ± 0.14	2.32 ± 0.09	3.70 ± 0.20	3.00 ± 0.05	4.50 ± 0.20
First finger length	0.65 ± 0.05	0.75 ± 0.05	0.68 ± 0.06	1.16 ± 0.24	0.86 ± 0.04	1.36 ± 0.17	0.65 ± 0.05	1.20 ± 0.08

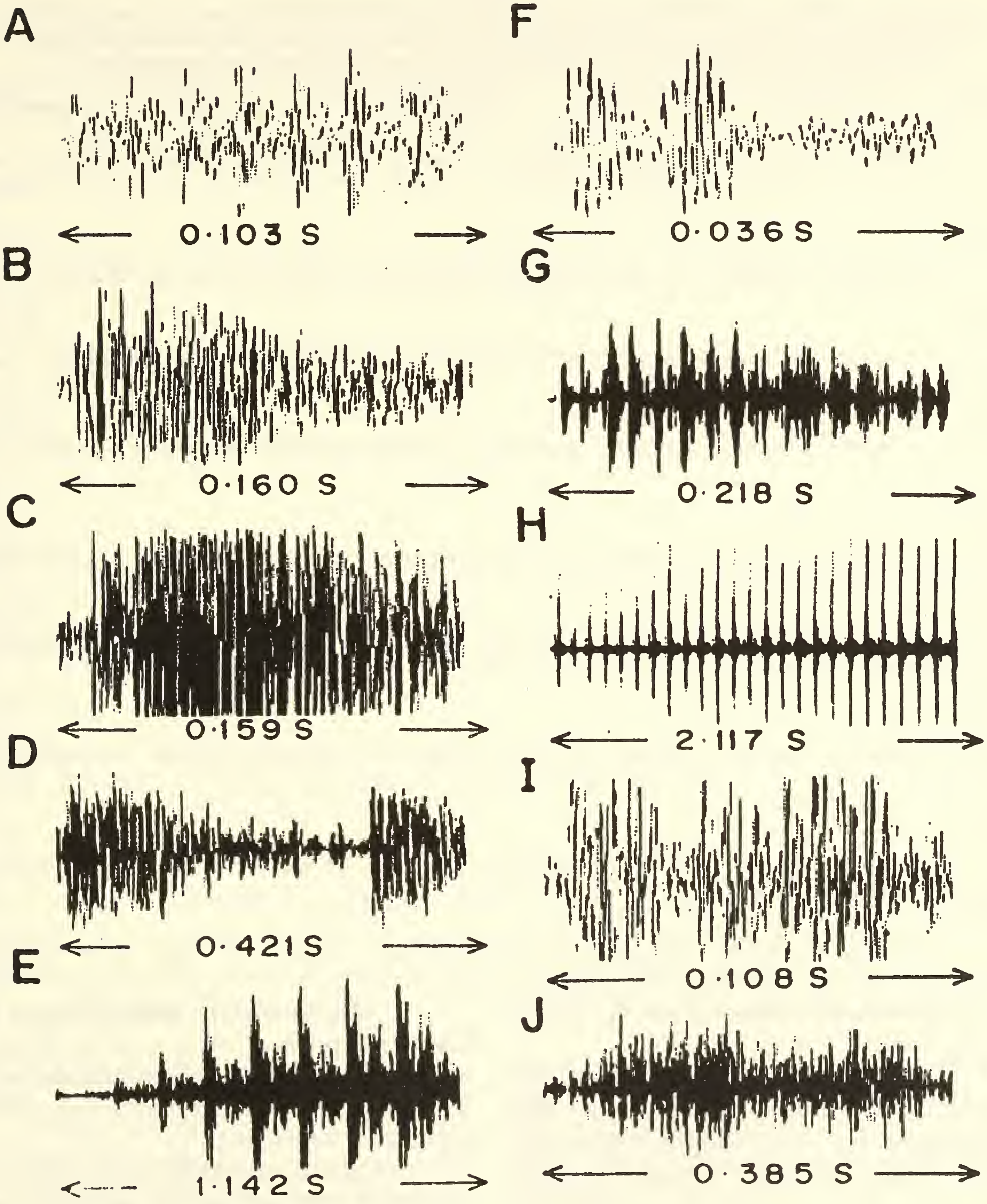


Fig. 1. Oscillograms shown as waveform display of amplitude versus time trace for a single mating call of - a. *Limnonectes limnocharis*; b. *Limnonectes khasiana*; c. *Hyla annectens*; d. *Polypedates maculatus*; e. *Euphlyctis cyanophlyctis*; f. *Rana alticola*; g. *Polypedates leucomystax*; h. *Amolops formosus*; i. *Bufo melanostictus*; j. *Hoplobatrachus tigerinus*.
(FFT length - 256; Overlap - 50%; Windows - Hamming)

TABLE 2

BIOMETRIC RATIOS OF *LIMNONECTES LIMNOCHARIS, LIMNONECTES KHASIANA, HYLA ANNECTENS, POLYPEDATES MACULATUS, EUPHLYCTIS CYANOPHLYCTIS, RANA ALTICOLA, POLYPEDATES LEUCOMYSTAX, AMOLOPS FORMOSUS, BUFO MELANOSTICTUS, HOPLOBATRACHUS TIGERINUS*

Characters	*L. limnocharis*		*L. khasiana*	*H. annectens*		*P. maculatus*		*E. cyanophlyctis*	
	Male (10)	Female (10)	Male (3)	Male (7)	Female (5)	Male (10)	Female (6)	Male (10)	Female (10)
Head width (Min) /Head width (Max)	0.63 ± 0.04	0.65 ± 0.05	0.35 ± 0.05	0.59 ± 0.02	0.46 ± 0.00	0.63 ± 0.06	0.64 ± 0.02	0.58 ± 0.07	0.71 ± 0.14
Snout length /Head width (Min)	0.73 ± 0.11	0.66 ± 0.06	0.68 ± 0.02	0.79 ± 0.08	1.03 ± 0.03	0.70 ± 0.05	0.74 ± 0.05	0.86 ± 0.12	0.69 ± 0.08
Eye diameter /Inter ocular distance	1.30 ± 0.08	1.25 ± 0.04	1.29 ± 0.04	0.85 ± 0.21	0.85 ± 0.00	0.91 ± 0.43	1.11 ± 0.07	1.32 ± 0.08	1.23 ± 0.02
Nostril diameter /Inter narial distance	0.43 ± 0.04	0.42 ± 0.04	0.14 ± 0.00	0.57 ± 0.14	0.50 ± 0.00	0.39 ± 0.13	0.28 ± 0.05	0.68 ± 0.04	0.69 ± 0.04
Tibia length /Fourth toe length	0.96 ± 0.13	0.99 ± 0.09	2.00 ± 0.08	0.95 ± 0.02	0.91 ± 0.00	1.10 ± 0.05	1.17 ± 0.03	0.91 ± 0.10	0.87± 0.01
First finger length /Lower fore limb length	0.47 ± 0.04	0.49 ± 0.03	0.34 ± 0.01	0.21 ± 0.01	5.40 ± 0.00	0.32 ± 0.03	0.32 ± 0.02	0.59 ± 0.08	0.54 ± 0.06
Total fore limb length/Body length	0.41 ± 0.03	0.44 ± 0.02	0.59 ± 0.02	0.71 ± 0.02	0.70 ± 0.00	0.67 ± 0.02	0.63 ± 0.03	0.46 ± 0.03	0.46 ± 0.02
Body length /Hind limb length	0.63 ± 0.03	0.61 ± 0.03	0.66 ± 0.005	0.66 ± 0.02	0.66 ± 0.00	0.62 ± 0.01	0.63 ± 0.03	0.66 ± 0.03	0.67 ± 0.01

Limnonectes khasiana (Plate 1b, ABC & Fig. 1b; Tables 1, 2 & 3)

1. **Habit and Habitat**: This species is not found commonly. During our study only 3 adult calling males were collected. No females were found. Chanda (1994) reported that although this species has been recorded from Meghalaya (Bowerger 1882), he did not come across even a single specimen during his study.

2. **Coloration** (Plate 1b. A): Tiny reddish brown species. Dorsal side with brownish triangular dark patches; ventral surface light brown with dark patches.

3. **Morphometric measurements and biometric ratios** (Tables 1 & 2): Absolute measurements of 15 morphometric characters and 8 biometric ratios were recorded from 3 males. No females were found.

4. **Call characteristics** (Plate 1b.BC & Fig. 1b; Table 3): The calls are loud and given in rapid succession. Each call lasts about 0.151 s with many pulses, given at approximately 0.219 s. It is a harmonic call having dominant frequencies at about 0.67 kHz, 1.34 kHz and 3.01 kHz. The frequency domain lies in the range of 0.35 kHz to 4.20 kHz, the SPL of the call being 53.29 dB.

TABLE 2 *(contd.)*
BIOMETRIC RATIOS OF *LIMNONECTES LIMNOCHARIS, LIMNONECTES KHASIANA, HYLA ANNECTENS, POLYPEDATES MACULATUS, EUPHLYCTIS CYANOPHLYCTIS, RANA ALTICOLA, POLYPEDATES LEUCOMYSTAX, AMOLOPS FORMOSUS, BUFO MELANOSTICTUS, HOPLOBATRACHUS TIGERINUS*

Characters	*Rana alticola*		*Polypedates leucomystax*		*Amolops formosus*		*B. melanostictus*	*H. tigerinus*
	Male (7)	Female (6)	Male (10)	Female (10)	Male (10)	Female (10)	Male (10)	Male (10)
Head width (Min) /Head width (Max)	0.67 ± 0.02	0.65 ± 0.01	0.66 ± 0.03	0.66 ± 0.004	0.66 ± 0.01	0.70 ± 0.07	0.57 ± 0.03	0.81 ± 0.04
Snout length /Head width (Min)	0.88 ± 9.42	0.58 ± 0.08	0.76 ± 0.05	0.71 ± 0.02	0.71 ± 0.02	0.64 ± 0.05	0.68 ± 0.02	0.54 ± 0.02
Eye diameter /Inter ocular distance	1.33 ± 0.09	1.47 ± 0.27	0.89 ± 0.15	0.72 ± 0.00	1.88 ± 0.09	1.28 ± 0.008	1.61 ± 0.04	1.49 ± 0.03
Nostril diameter /Inter narial distance	0.41 ± 0.06	0.36 ± 0.03	0.24 ± 0.01	0.23 ± 0.03	0.35 ± 0.03	0.27 ± 0.03	0.51 ± 0.09	0.36 ± 0.04
Tibia length /Fourth toe length	1.06 ± 0.02	1.08 ± 0.005	1.19 ± 0.12	1.30 ± 0.21	1.31 ± 0.04	1.24 ± 0.02	0.96 ± 0.00	1.02 ± 0.04
First finger Length /Lower fore limb length	0.39 ± 0.05	0.45 ± 0.02	0.28 ± 0.02	0.30 ± 0.05	0.36 ± 0.004	0.36 ± 0.02	0.21 ± 0.01	0.26 ± 0.01
Total fore limb length/Body length	0.56 ± 0.05	0.48 ± 0.005	0.63 ± 0.02	0.61 ± 0.01	0.72 ± 0.01	0.58 ± 0.04	0.64 ± 0.01	0.49 ± 0.10
Body length /Hind limb length	0.69 ± 0.01	0.71 ± 0.005	0.64 ± 0.02	0.70 ± 9.42	0.49 ± 0.009	0.59 ± 0.02	0.78 ± 0.06	0.67 ± 0.11

Hyla annectens (Plate 1c.ABC & Fig. 1c; Tables 1, 2 & 3)

1. **Habit and Habitat**: Commonly known as the garden frog, mainly found in potato fields and in gardens, climbing from one tree to another. Out of the 260 valid species of this genus from the world, it is the only species found in northeast India.

2. **Coloration** (Plate 1c.A): Dorsal surface dark green with a light brown streak from eyes to nostrils; a black lateral streak present upto groin, often terminating in black spots of different sizes with interconnections; ventral surface of the thigh yellowish; a few black spots arranged more or less in line on the ventral surface of the femur and tibia.

3. **Morphometric measurements and biometric ratios** (Tables 1 & 2): Absolute measurements of 15 morphometric characters and 8 biometric ratios were recorded from 7 males and 5 females.

4. **Call characteristics** (Plate 1c.BC & Fig.

TABLE 3

ACOUSTIC ANALYSIS OF THE MATING CALLS OF *LIMNONECTES LIMNOCHARIS, LIMNONECTES KHASIANA,HYLA ANNECTENS, POLYPEDATES MACULATUS, EUPHLYCTIS CYANOPHLYCTIS, RANA ALTICOLA, POLYPEDATES LEUCOMYSTAX, AMOLOPS FORMOSUS, BUFO MELANOSTICTUS, HOPLOBATRACHUS TIGERINUS*

Species	C.D.	C.P.	P.N.	L.F.	H.F.	D.F.	SPL
L. limnocharis	x 0.110 n 0.008	x 0.252 n 0.030	x 56 n 4.2	x 0.35 x 0.06	x 4.40 x 0.30	x 1.08 x 0.06	x 68.10 x 3.17
L. khasiana	x 0.151 n 0.001	x 0.219 x 0.020	x many n —	x 0.35 n 0.04	x 4.20 n 0.02	x 0.67 n 0.03 x 1.34 n 0.01 x 3.01 n 0.02	x 53.29 n 1.52
H. annectens	x 0.166 n 0.006	x 0.321 n 0.070	x many n —	x 0.37 n 0.02	x 4.80 n 0.10	x 1.81 n 0 x 2.78 n 0.09	x 57.48 n 0.52
P. maculatus	x 0.389 n 0.050	x 2.427 n 0.390	x 105 n 22.22	x 0.36 n 0.02	x 4.06 n 0.13	x 0.73 n 0	x 58.29 n 1.71
E. cyanophlyctis	x 1.122 n 0.370	x 3.574 n 0.490	x 9 n 4.44	x 0.33 n 0.03	x 4.36 n 0.23	x 0.78 n 0 n 1.42 n 0	x 62.03 n 1.71
R. alticola	x 0.020 n. 0.004	x 0.079 n 0.004	x 14 n 3.37	n 0.30 n 0.10	x 1.57 n 0.05	x 0.73 n 0.01	x 45.47 n 0.61
P. leucomystax	x 0.182 n 0.030	x 10.369 n 1.550	x 13 n 2.23	x 1.44 n 0.02	x 3.82 n 0.13	x 2.50 n 0.18	x 50.46 n 4.78
A. formosus	x 1.840 n 0.520	x 8.802 n 0.420	x 21 n 9	x 1.42 x 0.05	x 2.71 n 0.06	x 2.07 n 0 x 2.45 n 0	x 52.70 n 1.62
B. melanostictus	x 0.103 n 0.010	x 0.134 n 0.010	x 105 n 19.18	x 0.34 n 0.04	x 4.01 n 0.13	x 1.69 n 0.01	x 59.21 n 1.34
H. tigerinus	x 0.290 n 0.080	x 1.011 n 0.290	x 16 x 1.0	x 0.30 n 0.02	x 4.32 n 0.14	x 0.52 n 0.02 x 1.65 n 0.03	x 61.09 n 0.65

C.D. = Call duration in seconds; C.P. = Call period in seconds; P.N. = Pulse number; L.F. = Lower frequency in kilohertz; H.F. = Higher frequency in kilohertz; D.F. = Dominant frequency in kilohertz; SPL = Sound pressure level in decibels; x = Mean; n = Standard deviation.

The number of calls for each species is 20. Calls are of the male frogs.

1c; Table 3): The calls are loud and noisy. Each call lasts for about 0.166s with many pulses, given at intervals of 0.321 s. The call is harmonic having dominant frequencies at about 1.81 kHz and 2.78 kHz. The frequency domain extends from about 0.37 kHz to 4.80 kHz, the SPL of the call being 57.48 dB.

Polypedates maculatus (Plate 1d.ABC & Fig. 1d; Tables 1, 2 & 3)

1. **Habit and Habitat**: Found in paddy fields and marshy grasslands, also among potato and bean plantation. The calling males conceal themselves under potato leaves or other vegetation.

2. **Coloration** (Plate 1d.A): Dorsally yellowish brown to dark brown, limbs with brown and white cross bars of irregular patterns; thighs and throat light brown to yellowish; the chin and throat bear large dark oval spots.

3. **Morphometric measurements and biometric ratios** (Tables 1 & 2): Absolute measurements of 15 morphometric characters and 8 biometric ratios were recorded from 10 males and 6 females.

4. **Call characteristics** (Plate 1d. BC & Fig. 1d; Table 3): The calls are loud and distinct. At the initiation of the call, the calls have two distinct components. With the passage of time the components go on increasing in number. Each call lasts for about 0.389s, having as many as 105 pulses, given at intervals of 2.427 s. The call has a single dominant frequency at about 0.73 kHz, the frequency domain extending from about 0.36 kHz to 4.06 kHz. the SPL of the call being 58.29 dB.

Euphlyctis cyanophlyctis (Plate 1e. ABC & Fig. 1e; Tables 1, 2 & 3)

1. **Habit and Habitat**: These frogs are aquatic, found in pools, muddy swamps and canals and remain in water for long without coming onto the land. They spend most of their time floating motionless, with eyes and tip of the snout above water. When alarmed they skitter across the water surface for several feet before diving to the bottom to hide.

2. **Coloration** (Plate 1e. A): Dorsal surface light olive green or brown to almost black with irregularly arranged sooty spots; posterior surface of thigh dark, often with one or two yellow or white, irregular, longitudinal stripes; ventral surface white or with dark speckling; vocal sacs dusky.

3. **Morphometric measurements and biometric ratios** (Tables 1 & 2): Absolute measurements of 15 morphometric characters and 8 biometric ratios have been compiled for 10 males and 10 females.

4. **Call characteristics** (Plate 1e. BC & Fig. 1e; Table 3): The calls have distinct pulse components, which increase with the passage of time. Each call lasts for about 1.122 s, having about 9 pulses, given at call intervals of about 3.574 s. The call is harmonic, having dominant frequencies at about 0.78 kHz and 1.42 kHz. The frequency domain extends from about 0.33 kHz to 4.36 kHz, the SPL being 62.03 dB.

Rana alticola (Plate 1f. ABC & Fig. 1f; Tables 1, 2 & 3)

1. **Habit and Habitat**: Found in ponds, ditches, beels and low lying areas abundant in aquatic vegetation.

2. **Coloration** (Plate 1f. A): Dorsally yellowish to light brown; two distinct glandular dorsolateral folds running anterior to posterior, ending near the groin. Another glandular fold running from below the eyes and tympanum to the shoulder.

3. **Morphometric measurements and biometric ratios** (Tables 1 & 2): Absolute measurements of 15 morphometric characters and 8 biometric ratios have been compiled for 7 males and 6 females.

4. **Call characteristics** (Plate 1f. BC & Fig. 2f; Table 3): The calls are repeated very rapidly. Each call lasts for about 0.020 s, having approximately 14 pulses, given at a call interval of 0.079 s. The call has a single dominant frequency at about 0.73 kHz, the frequency domain lies between 0.30 kHz to 1.57 kHz, the SPL of the call being 45.47 dB.

Polypedates leucomystax (Plate 1g. ABC & Fig. 1g; Tables 1, 2 & 3)

1. **Habit and Habitat**: This species was mostly collected from Assam. They are found on creepers entwining bamboo fencing or tall grass near the vicinity of water.

2. **Coloration** (Plate 1g.A): Dorsal surface and sides olive to yellowish green; broad pale stripes on dorsolateral folds running between eyelids and groin; ventral surface cream; dorsal surface of legs olive brown with dark markings arranged longitudinally in lines.

3. **Morphometric measurements and biometric ratios** (Tables 1 & 2): Absolute measurements of 15 morphometric characters and 8 biometric ratios have been compiled for 10 males and 10 females.

4. **Call characteristics** (Plate 1g. BC & Fig, 1g; Table 3): Distinct well spaced calls, total call duration being approximately 0.182s with about 13 pulses, given at intervals of about 10.369s. The call has a single dominant frequency at about 2.50 kHz and the frequency domain extends from 1.44 kHz to 3.82 kHz, the SPL of the call being 50.46 dB.

Amolops formosus (Plate 1h. ABC & Fig. 1h; Tables 1, 2 & 3)

1. **Habit and Habitat**: Found by the sides of streams as well as in uninhabited forest caves.

2. **Coloration** (Plate 1h.A): Green with black patches on dorsal surface; ventrally creamish with black patches mostly concentrated on lower jaw and throat.

3. **Morphometric measurements and biometric ratios** (Tables 1 & 2): Absolute measurements of 15 morphometric characters and 8 biometric ratios have been compiled for 10 males and 10 females.

4. **Call characteristics** (Plate 1h.BC & Fig. 1h; Table 3): Can be mistaken for an insect call. The call is a long continuous trill. Sometimes the call consists of two components, a main trill ending with a beep. The call duration is about 1.840 s, having about 21 pulses. With the passage of time the number of pulses increases. The call is given at intervals of 8.802 s. It is a harmonic call with dominant frequency at about 2.07 kHz. and 2.45 kHz. The frequency domain extends from 0.30 kHz to 4.32 kHz, the SPL of the call being 52.7 dB.

Bufo melanostictus (Plate 1i. ABC & Fig. 1i; Tables 1, 2 & 3)

1. **Habit and Habitat**: This species is found throughout the year, mainly on land, under stones and other damp places.

2. **Coloration** (Plate 1i.A): Brown to yellowish brown dorsally with black spots; tips of warts and ridges of head usually deep brown to black; ventrally creamish, at times with light brown spots.

3. **Morphometric measurements and biometric ratios** (Tables 1 & 2): Absolute measurements of 15 morphometric characters and 8 biometric ratios have been compiled for 10 males. Data from females not taken into account, since the number of females collected was less than 5.

4. **Call characteristics** (Plate 1i. BC & Fig. 1i; Table 3): The loud croaks can be heard from a distance. These are rapidly repeated calls, the call duration being approximately 0.103 s with as many as 105 pulses, given at intervals of about 0.134 s. The call has a single dominant frequency at about 1.69 kHz. The frequency domain extends from about 0.34 kHz to 4.01 kHz, the SPL of the call being 59.21 dB.

Hoplobatrachus tigerinus (Plate 1j. ABC & Fig. 1j; Tables 1, 2 & 3)

1. **Habit and Habitat**: Commonly known as tiger frog, and always found near water in weed-choked ponds, ditches, tanks and marshes. During monsoon they are widespread in flooded lowlands. Mostly found singly, on sunny days they often spend hours crouched in grass or at the entrance of drains and culverts. Though strong jumpers and swimmers, they are easy to catch since they keep sitting motionless for hours together.

2. **Coloration** (Plate 1j.A): The dorsal coloration of the adult is light brown to olive,

with grey or brown spots; younger frogs paler, mostly grass green in colour; distinct, narrow, cream coloured stripe from snout to vent, and light line along upper surface of thigh and posterior aspect of tibia to heel.

3. **Morphometric measurements and biometric ratios** (Tables 1 & 2): Absolute measurements of 15 morphometric characters and 8 biometric ratios have been compiled for 10 males. Data from female frogs have not been taken into account since the number of females collected was less than 5.

4. **Call characteristics** (Plate 1j. BC & Fig. 1j; Table 3): These frogs have deep hoarse calls. The call duration is about 0.290 s with 16 pulses, call interval being approximately 1.011 s. It is a harmonic call, with dominant frequencies at about 0.52 kHz and 1.65 kHz, the frequency domain extending from 0.30 kHz to 4.32 kHz. The SPL of the call is 61.09 dB.

Discussion

Until two decades ago amphibian taxonomy was mainly based on description and measurements of morphological characters alone. Although Kauri (1959), Berger (1966) and Tinsley (1973, 1975) had emphasized that absolute measurements of body parts may vary but their biometric ratios remain almost constant in individuals within the same species, not many workers have used these parameters for Indian amphibia.

From the early 1980's, with the availability of sophisticated call recording instruments and computerised call pattern analysis programs (Fast Fourier Transformation - FFT), the role of species-specific mating call pattern has come to be understood as an important mechanism for reproductive isolation and speciation. Asian and European species, which on the basis of their morphological characters were categorised as one species, were shown by call analysis to belong to more than one species. The question is whether mere deviation in call pattern should be basis for species identification or should there also be an attempt to correlate call differences with differences in biometric ratios of morphological characters. The answer would be — when an intraspecific call variation is recorded, the biometric ratios of the individuals that differ in call pattern should also be worked out. If both the call pattern and the biometric ratios vary from the known records, only then should it be recorded as a new species.

Northeast India has a wide ranging climatic variation along with different types of vegetation. This is mainly due to the existence of high mountain ranges in close proximity to lowlands. Thus zones with similar climate are separated at close range by zones of different climates. This kind of biotope favours speciation, making the northeast a "hot spot" of amphibian speciation. Inspite of such richness, the difficult terrain and inaccessibility of the core area has resulted in the northeast remaining relatively unexplored.

In view of the present situation and the facilities available, it was felt that with the use of biometric ratios and bioacoustic analysis of call pattern, many new species could be identified. This work has for the first time combined morphometric measurements, biometric ratios and call analysis for Indian amphibian systematic studies, along with the coloration pattern of live specimens.

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THE LIFE EXPECTANCY OF THE WILD PIG *SUS SCROFA* L. IN RUHUNA NATIONAL PARK, SRI LANKA[1]

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(*With five text-figures and one plate*)

Key words: Age determination, cementum, life expectancy, mortality, life table, *Sus scrofa*, herbivores

A pick-up collection of skulls in Ruhuna National Park, made to determine age at death of ruminant herbivores through study of layering in the cementum of their molar teeth, also contained skulls with teeth of 29 adult wild pig (*Sus scrofa*). Layering present in the dentine of the tusks cannot be used to determine age. But layering in the cementum of the molars, although generally less clearly marked than in water buffalo (*Bubalus bubalis*), has permitted the determination of age at death in 23 specimens. The pattern of dark layers resembles that in *Bubalus*, with strongly and weakly marked lines alternating, corresponding with the major and minor dry seasons. It differs from that in sambar (*Cervus unicolor*) and chital (*Axis axis*) where a dark layer forms only in the main dry season each year. The mean life expectancy of young adults is 6.0 years and the maximum 12 years, with no evidence of distinction between the sexes, a situation very similar to that in the water buffalo. But juvenile mortality due to predation is dramatically greater in wild pig, compensated for by a correspondingly higher fecundity than in water buffalo. Sambar and chital both have longer life expectancies as adults than water buffalo or wild pig.

Introduction

The wild pig *Sus scrofa* L. is an adaptable omnivore distributed generally in the broad-leaved forest and steppe regions of the Palaearctic, extending through southern and southeast Asia to Java, Bali, Flores and the Solomon Islands (Honacki, Kinman and Koeppl 1982), and introduced as domestic or feral stock widely elsewhere. In Sri Lanka, as the sub-species *Sus scrofa cristatus,* it is a prominent mammalian component of the ecosystem, particularly in the dry zone of the country (Santiapillai and Chambers 1980, de Silva *et al.* 1995). This habitat is seen in a pristine form in Wilpattu and Ruhuna (Yala) National Parks (for location see Fig. 1). It is very active as an opportunistic feeder on the more succulent elements in the vegetation, particularly underground storage organs, and on carrion. Corpses are dismembered within a few hours of death.

Inspite of the richness of its fauna of mammals, as of other land vertebrates, there has been little study of the ecology of the mammals in southern and southeastern Asia. Schaller (1967) undertook a pioneering study of the ecological relations of the large herbivores and predators in Kanha National Park, Madhya Pradesh, as representative of the drier forests of peninsular India, including an outline analysis of the age structure of the large herbivores, but it could only concern indices of age as his estimates were based on tooth-wear alone. Eisenberg and Lockhart (1972) conducted an outline survey of the ecology of large mammals in Wilpattu National Park in Sri Lanka. This has been followed by more specific studies on the

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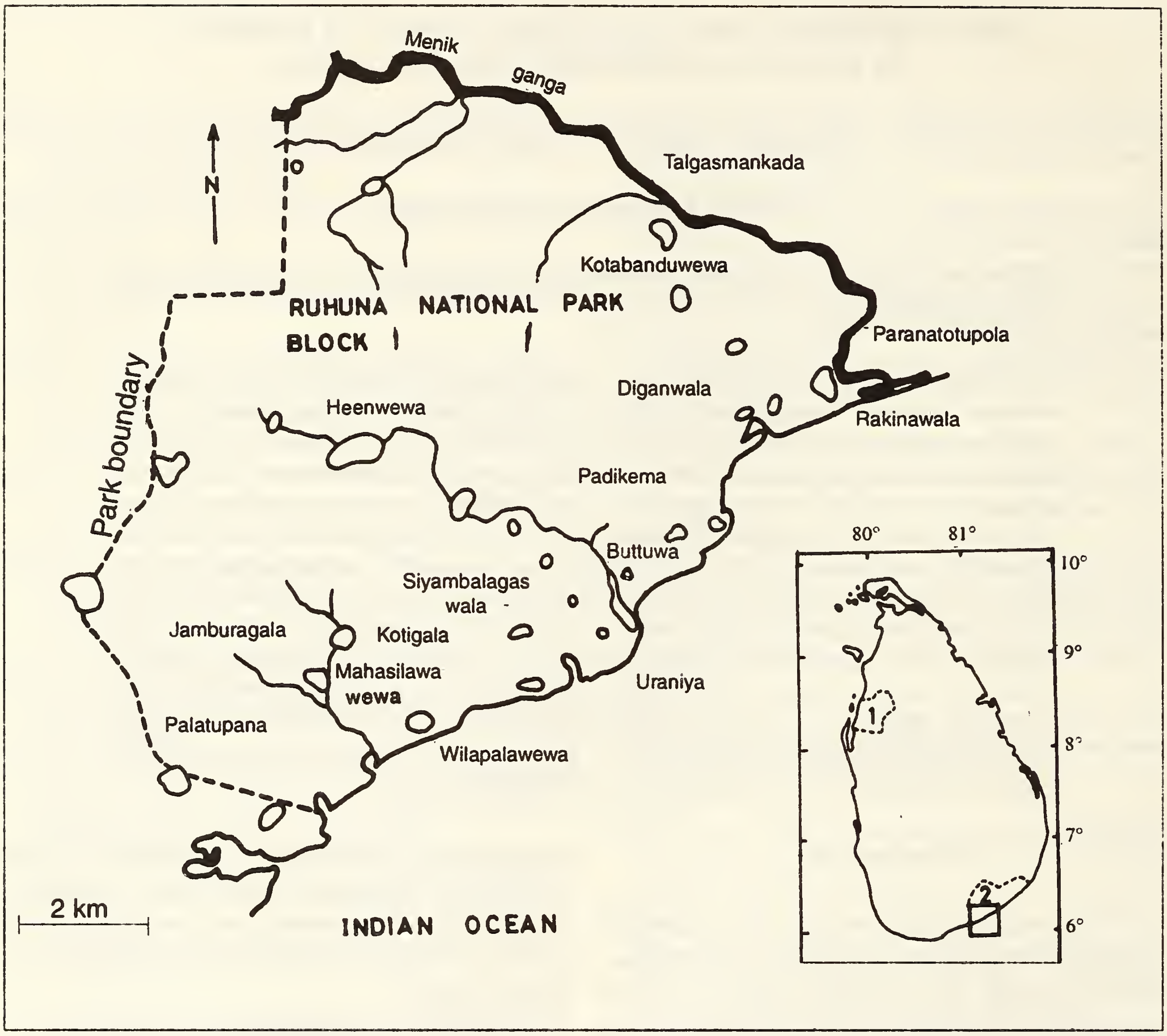

Menik
ganga
N
Talgasmankada
Kotabanduwewa
RUHUNA NATIONAL PARK
BLOCK I
Paranatotupola
Diganwala
Rakinawala
Heenwewa
Park boundary
Padikema
Buttuwa
Siyambalagas wala
Jamburagala
Kotigala
Mahasilawa wewa
Uraniya
Palatupana
Wilapalawewa
2 km
INDIAN OCEAN
80°
81°
10°
9°
8°
7°
6°
1
2

Fig. 1. The study area in Ruhuna National Park (Block I, the southwestern section), and the position of Wilpattu (#1) and Ruhuna (#2) National Parks in Sri Lanka.

population densities and annual breeding cycles of the large herbivores, and of the leopard *Panthera pardus* as the main large predator, in Block I, the southwestern part of the coastal section of Ruhuna National Park (Santiapillai *et al.* 1981, Santiapillai *et al.* 1982, Santiapillai *et al.* 1984) including one on the pig *Sus scrofa* (Santiapillai and Chambers 1980). However, there was no attempt to determine the age structure of the species concerned.

As much of the coastal section of the Park is short-grass prairie and population densities are high, it is possible to find skeletons of the large mammals which have died in that area without a disproportionate expenditure of labour. Searching is aided by the ground being firm and dry throughout the main dry season from July to early October. From 1981 through 1985, annual searches were made to find skulls, which resulted in a collection of over 300 specimens. It was found, initially in water buffalo (*Bubalus bubalis*) that the well marked annual pattern of wet and dry seasons was matched by corresponding layering in the cementum of the molar teeth with, as in the case of the herbivores of the African savannah (Grimsdell, 1973), dark lines in the cementum corresponding with periods of drought. With increasing experience it was found that the number of layers could also be determined in sambar deer (*Cervus unicolor*) and chital (*Axis axis*), where the main problem in counting resulted from irregularity in layering, and finally in the pig (*Sus scrofa*), where the main problem has been the frequency of a combination of a densely opaque white background coloration of the cementum with weakness of definition of the incremental lines. Despite the problems encountered, 85% to 95% of the molar teeth yielded counts of the number of layers in the four species involved. Preliminary accounts of the findings were published by Ashby and Santiapillai (1986), Ashby and Santiapillai (1991). Final publication was delayed in the expectation that further collection of material would permit calculation based on larger sample sizes, which was particularly desirable in the case of pig and chital. However, added to the difficulty of organizing collection of material in the field in the years since 1985, the epidemic of swine fever in 1989 (De Silva *et al.*, 1995) massively disturbed the age structure of the pig population. Therefore we decided to publish the data resulting from the skulls collected from 1981 through 1985 in the belief that the life table of the pig which has been constructed and the statistical data on resulting wear, though lacking in detail, are reliable in their broad characteristics.

MATERIAL AND METHODS

Material obtained in the annual searches of coastal dunes, grass prairies, margins of water holes and open bush was supplemented by specimens found by game guards in the course of patrols. In the case of the pig, sections were made initially of both canines and molar teeth and both dentine and cementum examined. Layering was evident in the dentine of both types of teeth in some individuals, but given that no consistent relationship was observed between numbers of layers and age as indicated by tooth-wear, it was concluded that layering in the dentine was not a good measure of age. Attention was therefore focussed, as in the ruminants studied, on layering in the cementum of the molar teeth. The technique of preparation, which had to be unsophisticated, was based on the method which had proved successful with water buffalo and deer. First lower molars were bisected vertically and transversely to give vertical sections of the cementum and dentine between roots. The surface of the cementum and dentine was polished successively with a coarse and a fine grade of carborundum powder and then examined under a 12 x handlens and a strong unidirectional light, normally sunlight. It was found helpful to examine the specimens with incident light from various angles. Initially the number of layers was counted in specimens where layering was clear. It was then extended to those where it was less easy to discern. In all specimens, several independent assessments were made. This process eventually left a residium where no count of layers was possible. In addition the depth of both dentine and cementum in the section were measured with a micrometer. Where available, the two lower first molars were used and average values for parameters calculated. Where this was not the case, attention concerning layering was turned to upper first molars and if necessary, to more posterior molars. But the depth of dentine and cementum were used in calculating regressions only from first molars.

Estimate was made of tooth-wear in all specimens, based on Schaller's (1967) nine point scale which had been devised with deer particularly in mind. While the wear pattern in pigs is not identical to that in ruminants, given the differences in tooth and jaw structure and functioning, it is believed that a parallelism between given wear-classes in ruminants and pigs was achieved. A key wear-class in the series is number III which occurs at the end of the subadult

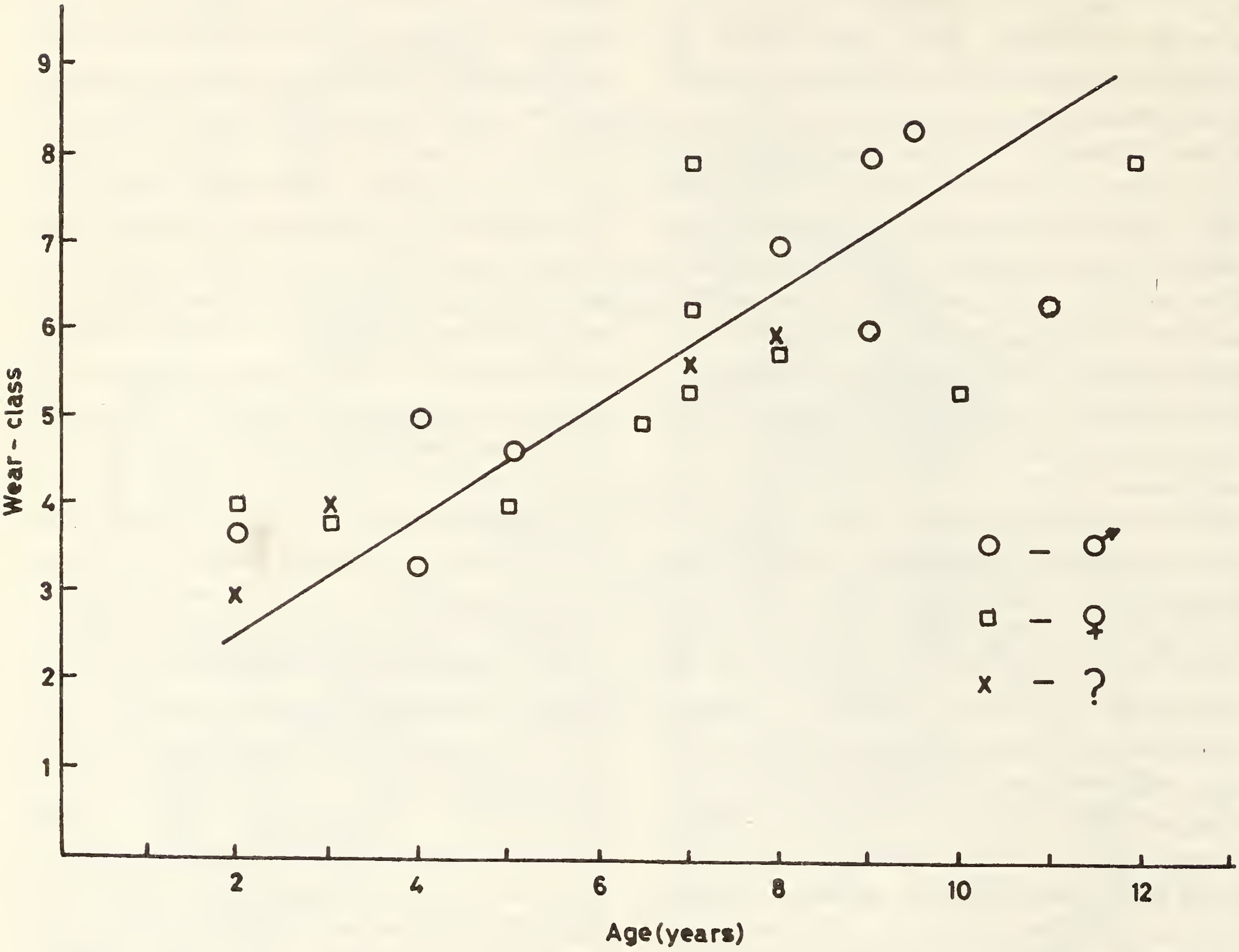


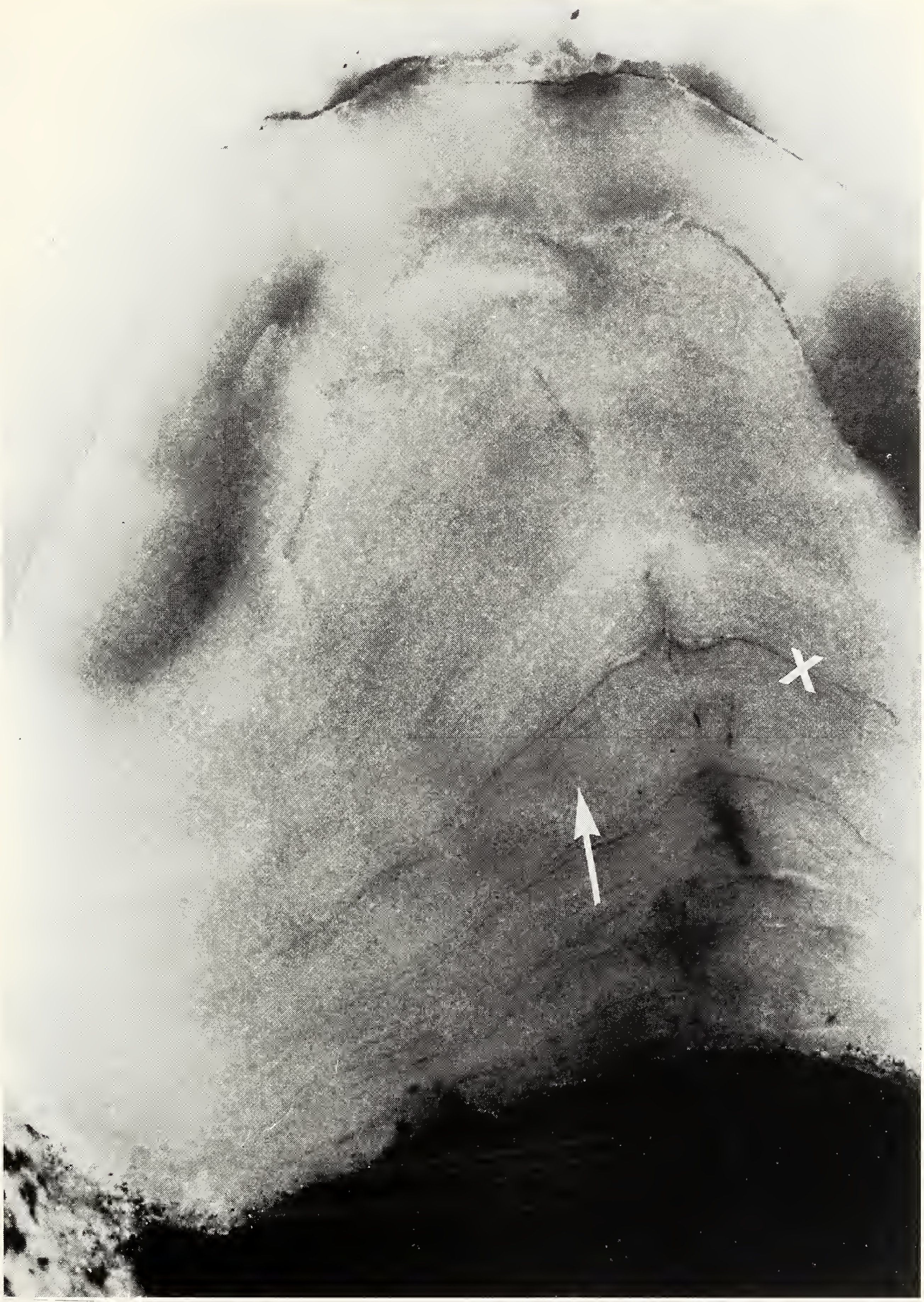
Fig. 2. Relation in wild pig (*Sus scrofa*) of wear of dentition to age as estimated from layering in dental cementum.

phase when the last molar is completing eruption. Analysis of data was simplified in the present instance by the fact that all the specimens found were already fully grown; where the whole of the lower jaw was available, its length provided confirmation of this fact. To make the estimation of tooth-wear more sensitive, each grade of wear was sub-divided into three, giving besides the typical expression of the class of wear (W), a W+ and a W- grading, with the + sign indicating one third progression towards the next older grade, and W- one third of a grade more youthful than the standard, giving effectively a 27 point scale. The most youthful specimen was judged to be in grade III.

Given that the tusks of males are larger than those of females, it was possible to judge the sex of specimens where canine teeth were present or at least the front end of the jaw was intact and therefore their sockets remained in cases where the canine had fallen out.

RESULTS AND CONCLUSIONS

There were 29 specimens with teeth present, and satisfactory sections of first or second molars were obtained in 27 of these. Estimates of age from layering were obtained in 23, and of depth of cement and of dentine in M1 in 20 specimens. For individuals where the two



Vertical section of cementum of M1 of wild pig with dentine above. Position of a main Dark Layer is marked by X and of an intermediate Dark Layer by an arrow. In this individual, faint intermediate lines were formed several times per year in its last years

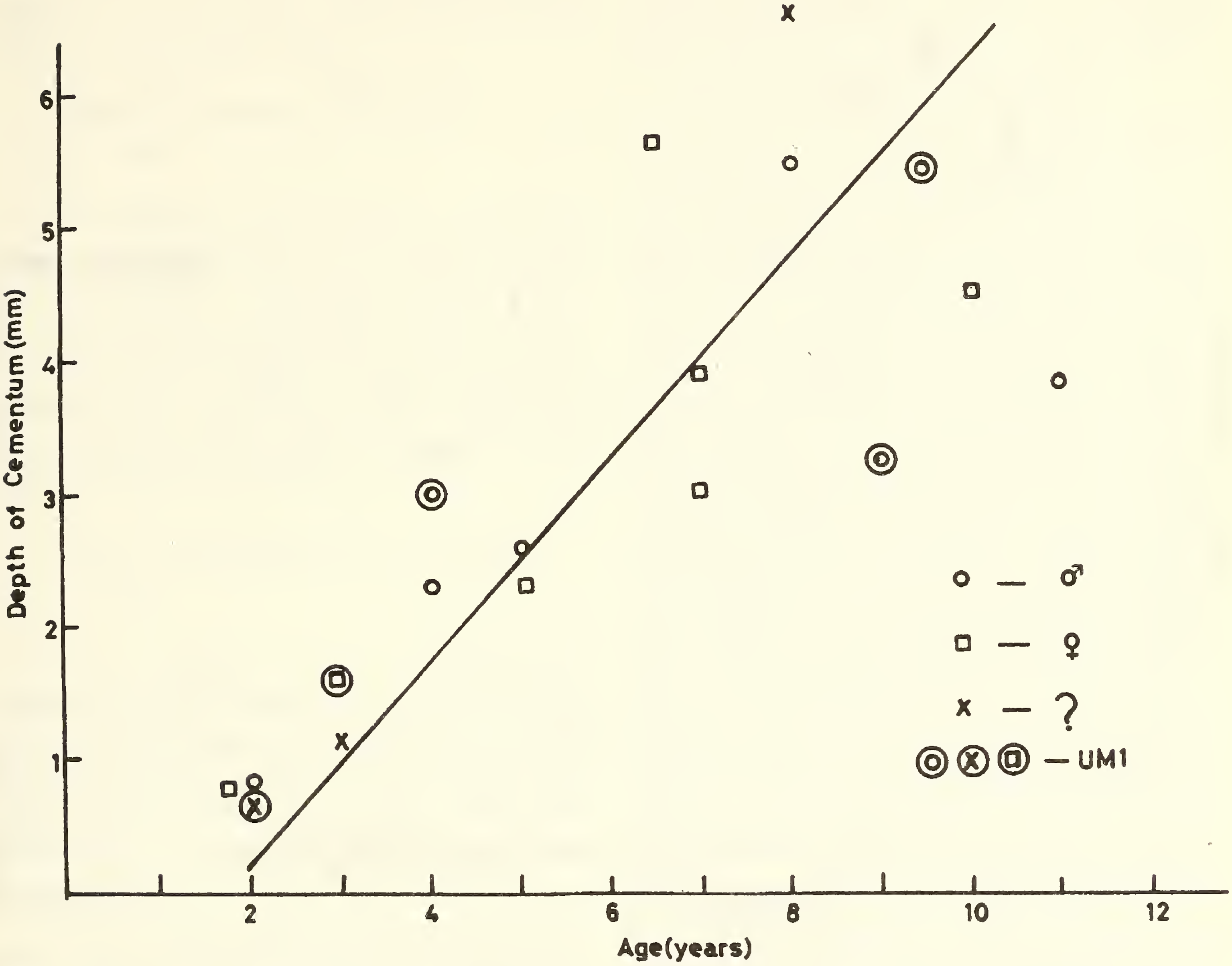


Fig. 3. Relation in wild pig of depth of cementum in bisected M1 to age as estimated from layering in cementum.

parameters concerned were determined, the relation of age as indicated by layering to wear-class is given in Fig. 2, its relation to depth of cementum in Fig. 3 and to depth of dentine in Fig. 4. In the absence of data from research, it has been assumed that the eruption of M1 is completed towards the age of one year and that cementum starts to form soon after eruption finishes. Since most births occur in March and April (Santiapillai and Chambers 1980) (although striped young are seen at other seasons), the first dark band in the cementum corresponding to the latter part of the main dry season, can be expected to form in M1 at about the age of one and a half years. It was therefore assumed that the age estimated from layering in M1 was the number of such layers plus one. Where both M1 and M2 were sectioned there was generally one more such layer in the cementum of M1 than in that of M2, therefore estimates of age based on M2 alone were calculated as the number of such layers +2.

In the specimens where layering is clearly shown (see Plate 1), there are faint dark layers in the cementum alternating with the main dark layers. This characteristic was apparent in most

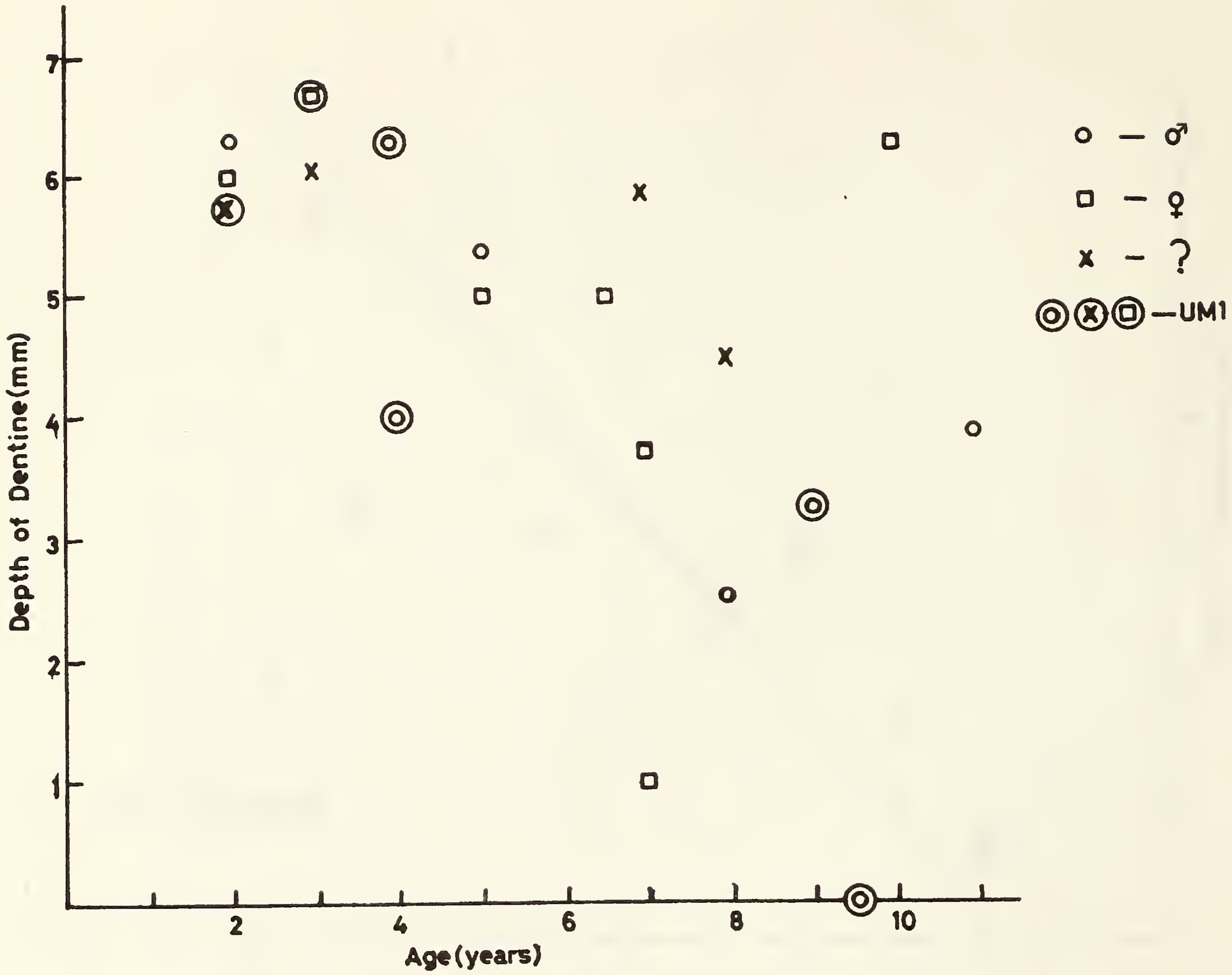


Fig. 4. Relation in wild pig of depth of dentine in bisected M1 to age as estimated from layering in cementum.

of the teeth in specimens of water buffalo, but in only a few specimens in deer species, and then only in old age. It was concluded that the faint dark layers correspond to the subsidiary dry season which occurs around February, and that it was much more prominent in buffalo than in deer because the former is a species grazing out in the open where the quality of forage is quickly affected by drought, whereas deer, more particularly sambar, are mainly browsers and feed on vegetation not much affected in quality by a short period of dry weather. The similarity of pig to buffalo in the pattern of layering may be attributed to its feeding mainly in open areas and at ground level and not on the shoots of shrubs or trees which, being deep-rooted, will be little affected by the short dry season. From Figs. 3 & 4, it will be seen that the rate of deposition of cement and of wear of dentine in upper M1 was not obviously different from that in lower M1 and the data from upper M1 teeth have therefore been included when calculating regressions. There was, likewise, no evidence of the relation of the various parameters differing in males and females. These conclusions applied also to water buffalo and sambar deer, and with the exception of a delayed start in cementum formation, to chital.

From Fig. 2, it is seen that there was a strong correlation between the estimates of wear and of age as estimated from layering, the regression equation for the range of age classes which occurred in the sample being:

Age = Wear Group x 1.53 - 1.96
r = 0.82

This compares with a value over the same range of wear-classes of r = 0.76 in water buffalo (N = 93), 0.83 (N = 77) in sambar deer, and 0.78 (N = 48) in chital for this relation. There was also a good overall correlation between depth of cement of M1 and number of annual layers as shown by Fig. 3. The regression equation with depth of cement (in mm) is:

Age = Cement depth x 0.13 + 1.93
r = 0.79

This compares with a correlation coefficient for the relationship of 0.92 in water buffalo, 0.89 in sambar deer and 0.74 in chital. There is a broader scatter of values in older pigs than in water buffalo and sambar, where the relationship of these parameters remains close throughout life.

In the relation between depth of dentine of M1 and age, it is seen from Fig. 4 that there are large differences in the rate of attrition of the dentine of M1 in different individuals inspite of the fact that for the overall dentition the relationship of wear to age is close. This feature was obvious on initial inspection of the specimens: individual teeth sometimes wore at considerably different rates, and such differences could occur within the length of individual molars. If individual variability is discounted, the data suggest that the rate of attrition of the dentine of M1 with increasing age is approximately linear. This pattern differs from that seen in the ruminants in this study. In these, wear was more markedly concentrated at the M1 level of the jaws than was the case in the pig: while the depth of dentine remained closely correlated with age, the rate of wear progressively lessened with time. In fact once eruption was completed, age as indicated by layering in M1 teeth of water buffalo and the two species of deer was proportional to the logarithm of the depth of the dentine.

Since there was no evidence of any marked difference in the life expectancy of the sexes, it is possible to construct an approximate life table for the pig based on the fairly small size of the sample of skulls obtained, and to compare it with those for the ruminants where samples were larger. The resulting curves deduced for the pig (N = 23) and that for water buffalo (N = 126) are given in Fig. 5. Since the youngest specimen of pig was at least 1.5 years old at death the present study gives no direct evidence of mortality prior to that age. However, its approximate value can be deduced from observational studies, given that the young pigs are easily seen and counted and not cryptic like the young of sambar deer. It is certain that neonatal and juvenile mortality is heavy and that predation by leopard (*Panthera pardus*) is an important cause. Eisenberg and Lockhart (1972) working in Wilpattu in a similar habitat, reported that 50% of the young pigs disappeared within one month of birth. Santiapillai and Chambers (1980) found that 75% of young pigs disappeared within one year. Since their study was based on visits made every three months, with the spring visit in May and the majority of births occurring in April, it can be concluded as an approximation that the young averaged one month of age when first seen. As a working hypothesis, it can therefore be concluded that mortality during the first thirteen months or so of life is in the order of seven eighths of those born. De Silva *et al.* (1995) give results in line with this conclusion.

From the data given in Fig. 5, it can be deduced that once the juvenile phase is past, the life expectancy of pig and water buffalo is similar. For individuals surviving at one year of age, the total mean life expectancy of the pig is 6.0 years, and of the water buffalo 5.6 years, with no evidence of a significant difference in this parameter between males and females. The

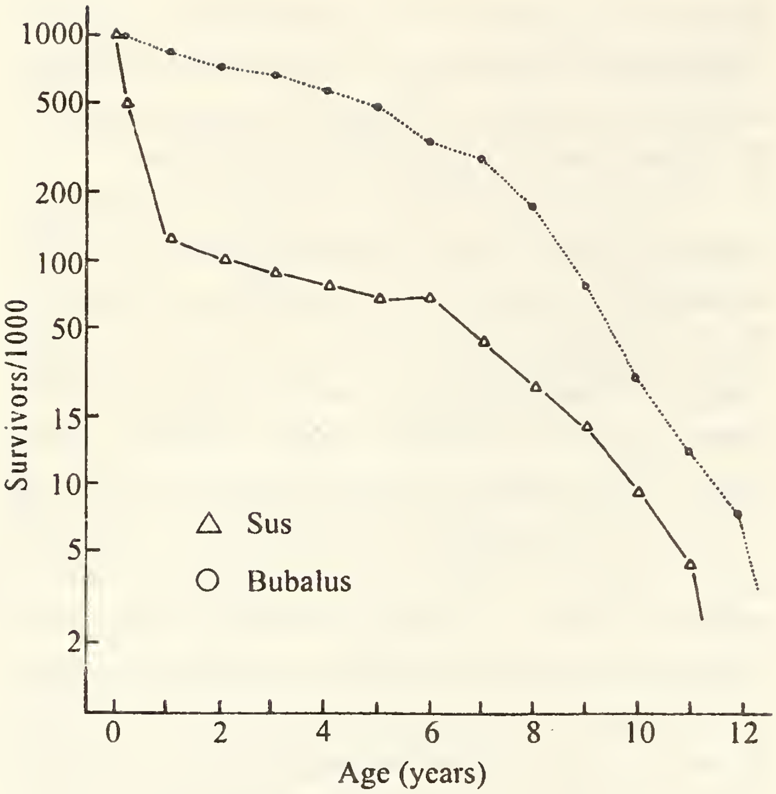


Fig. 5. Survival of wild pig compared with that of water buffalo (*Bubalus bubalis*) in Ruhuna National Park.

expected of length of reproductively active life in the females of the two species at Ruhuna is therefore similar, although perhaps rather longer in the pig than in the water buffalo as the former can give birth for the first time at 2 years of age and the buffalo at 3 years. The observed birth rate in the pig in Ruhuna National Park is in the order of 4 + per adult female per year, while in the water buffalo it is one per adult female per two years. On these data and assumptions, approximately 88% mortality in the pig when immature is balanced by a production of young per adult female which reaches maturity, eight times as great as in the water buffalo. Although the estimates are based on approximate data, the observations on juvenile mortality and on birth rate for the two species give concordant estimates and strengthen the likelihood that these are substantially accurate.

Discussion

The regime in Ruhuna National Park is one, like that in the savannahs of Africa, where predators take a large crop of herbivorous and polyphagous mammals of a size which they can profitably attack. The tiger (*Panthera tigris*) being absent from Sri Lanka, and leopard being the largest carnivore present and a solitary hunter, adults of water buffalo and probably also of sambar deer are too large to be predated. Water buffalo in good condition can also protect their young against the leopard. Its main prey, apart from juvenile pig, appears to include young and subadult chital, monkeys, and such medium sized species as the blacknaped hare (*Lepus nigricollis*). The juvenile pig may also be substantially at risk from the marsh crocodile (*Crocodylus palustris*) and the estuarine crocodile (*C. porosus*), which at Ruhuna National Park (RNP) though not growing to the size of crocodiles found in large rivers and other extensive water bodies, compensates for rather small individual bulk by their abundance in the larger water holes in the Park. As there appears to be little in the way of fish on which they can feed, their diet is dominated by corpses of animals which die nearby (which they drag into water within a few days, ending competition for the carrion from pigs), and the smaller of the mammals which come down to drink. Thus the pattern in RNP is for the largest of the herbivores, elephant and water buffalo, not to be substantially affected by predation at any age, while the young of the medium sized species, chital and more particularly the pig, suffer heavy predation prior to maturity and have a high juvenile mortality in consequence. Presumably the smaller mammals, apart from the bats and perhaps species like the Indian porcupine (*Hystrix indica*) with anti-predator devices, will suffer heavy predation at all stages of the life cycle, by the leopard and a variety of smaller predators.

The larger of the grazing mammals in RNP appear to be subject to a second important constraint affecting their life tables. Most of the oldest specimens of both water buffalo and pig, those approaching 12 years of age, had heavily worn dentition, and because of the reduction in length of cutting edges through loss of ridges of enamel adjoining dentine, particularly on the anterior molars, were probably losing efficiency. Lanyon and Sanson (1986) have commented that such loss of efficiency could be important as a mortality factor in herbivores with abrasive diets, and set an upper limit to longevity. There is good reason to believe that this applies to the water buffalo in RNP, since its maximum life span there is only a third of its potential longevity in domestication. The rapidity of attrition of its dentition may be attributed not only to a high silica content of grasses and sedges in the dry season, but also to the closeness to the ground to which the herbage is grazed, coupled with the gritty nature of the soil. Examination of its faeces has confirmed that it swallows large amounts of grit (R.D.A. Burge, pers. comm.). The extent to which the pig roots for its food increases the likelihood that there is a similar situation in this species.

In sambar deer the situation is considerably different. Whereas, as indicated by the regression of tooth-wear on age, each wear-group lasts on an average 1.42 years in the water buffalo and 1.53 years in the pig, in the sambar deer this figure averages 2.57 years. The much slower relative rate of wear may be attributed to the sambar being a browser, having a less abrasive diet, containing little grit. Correspondingly, the maximum age reached by sambar in RNP is much greater than in buffalo and pig, the oldest specimens found being estimated to have reached 24 years, and the mean life expectancy of individuals reaching adulthood being 10 years. The chital's situation is intermediate. It is predominantly a grazer under wet conditions and a browser during the drought (Balasubramaniam *et al.* 1980). Each dental wear-group lasts on an average 2.31 years, the maximum age observed is 14 years and the life expectancy of individuals reaching adulthood is estimated to be 6.6. years. Also intermediate is the African buffalo (*Syncerus caffer*) a close relative of the water buffalo, living in national parks in the Serengeti and in Uganda, where the herbage is less closely grazed than in RNP and the soil is probably less abrasive. Sinclair (1977) has reported that in these habitats its maximum life span is 18 years, and that its mortality rate starts to steepen after the low rate in early adult life, at 10 years of age as compared with 7 years of age in the case of water buffalo and pig in RNP.

If the above hypotheses are correct, one would expect wild pig to have a lower juvenile mortality in parts of its range where predation on its young is less intense and perhaps a longer maximum life span where diet is not so abrasive. Jezierski (1977) confirmed the former prediction, but reported in addition that in Europe the life span of *Sus scrofa* does not exceed 12 years. However, even with the constraints on survival which have been described, the pig remains very successful in RNP. If the estimates of population densities given by Ashby and Santiapillai (1986) and by de Silva *et al.* (1994) are accurate, the number of pigs born will be twice that of water buffalo, and amongst the larger mammals living there, may be exceeded only by the number of chital born.

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BREEDING ECOLOGY OF COMMON MYNA *ACRIDOTHERES TRISTIS* WITH SPECIAL REFERENCE TO THE EFFECT OF SEASON AND HABITAT ON REPRODUCTIVE VARIABLES[1]

SATWANT K. DHANDA AND MANJIT S. DHINDSA[2]

(*With three text-figures*)

Key words: Breeding ecology, *Acridotheres tristis,* breeding season, habitat effect, reproductive success

Breeding ecology of common myna *Acridotheres tristis* was studied in nest boxes and natural nests at Ludhiana, India. Breeding season extended from March to September. Nesting material included twigs, leaves, feathers, paper and plastics; the first two material types being used in significantly greater amounts. Size and fresh weight of eggs differed significantly among females, although successive eggs within a clutch did not differ significantly. Brood number, egg sequence and laying season did not affect egg size, whereas habitat around nests affected both the breadth and volume of eggs. Average clutch size was 4.29 ± 0.85 (sd). Clutch size did not vary with brood number and habitat but laying season affected it significantly. Clutches laid early in the season were bigger and there was a steady decline in average clutch size with the advancement of laying season. Brood number, laying season and habitat did not affect the number of eggs hatched or young fledged per clutch. Incubation period ranged between 11 and 14 days and averaged 12.73 ± 0.88 days. Hatching and nesting success were recorded as 66.1% and 34.4%, respectively. Average nestling period was 21.75 ± 2.78 days. Growth of nestlings showed sigmoid curve. Hatching failure and predation were the most important factors of egg mortality, whereas predation, intraspecific rivalry and starvation accounted for most of the nestling mortality. Significantly greater proportion of hole nests (80%) were successful (produced atleast one fledgling) compared with open nests (35.7%). Overall, an average production of 1.4 fledglings per nesting pair was recorded. This study suggests that laying season and habitat of the common myna significantly affect its clutch size and egg size respectively.

INTRODUCTION

The common myna *Acridotheres tristis,* one of the very common Indian birds, is distributed ubiquitously throughout the Indian subcontinent (Ali and Ripley, 1987). Reports on some breeding parameters of this species are available in literature from as early as 1889 when it was restricted to a few parts of the world (Long, 1981). Later on, it spread to neighbouring areas like Vietnam, Malaysia and Singapore as a result of extension of range. But it was deliberately introduced into Australia, New Zealand, Mauritius and certain other islands like Hawaii, Fiji and Malagasy to control insects (Long, 1981). Most of the introductions were successful probably because of its diverse feeding habits and its ability to accept any suitable site for nesting.

Despite the wide distribution and ecological importance of common myna, very meagre information is available on its breeding ecology (Lamba, 1963; Sengupta, 1968). The present study was conducted to obtain quantitative data on breeding of this species in an intensively cultivated habitat and to examine the effect of laying season and habitat on reproductive performance. A comparative account of

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reproductive performance of common myna in nest boxes and natural sites has been published elsewhere (Dhanda and Dhindsa, 1996).

MATERIAL AND METHODS

The study was conducted during 1992 in the campus of the Punjab Agricultural University, Ludhiana (30° 56' N, 75° 52' E, 247 m above msl), Punjab, India. The study area (*ca* 640 ha) includes large tracts of agricultural fields, fruit orchards and woodlots, in addition to university buildings and residences interspersed with roads and lawns. Trees are located around orchards, canal sides, poultry farms, fish farms and all along the campus roads.

Twenty-six nests of the common myna in natural sites were selected at random and marked for regular observations on various parameters of breeding ecology. Thirty nest boxes (15 wooden and 15 made of polyvinyl chloride (PVC), were put up in different parts of the study area during the last week of February. Each rectangular wooden nest box measured 22 x 22 cm at the base, 34 cm at the rear and 23 cm in front. A PVC pipe of 16 cm diameter was used for preparing circular nest boxes, each 33 cm high at the rear and 28 cm high in front, with a wooden base and a slanting lid. All boxes had an entrance hole (6 cm in diameter) on the front, 2.5 cm from the top. One box was placed in a building ventilator, whereas the remaining 29 boxes were fixed to trees at an average height of 3.95 ± 0.56 (sd) and facing different directions.

All nests were monitored daily during the egg laying period, twice a week after clutch completion and again daily near the expected date of hatching. Eggs were measured and weighed within 24 hrs of laying. Egg volume was calculated as 0.51 x length x $(\text{breadth})^2$ following Hoyt (1979). All young were weighed with a Pesola balance on alternate days till they were 17 days old, after which weighing had to be stopped as the nestlings tried to jump from the nest on approach. In nests where completed clutches or already hatched young were found, laying dates were calculated assuming that females laid one egg a day(d). Incubation started after laying of the last egg and lasted 13 d, and nestlings stayed in the nest for 22 d (Sandhu, 1993). The fledging date was recorded by daily observation of nests. After fledging, the nest contents (if dry) were sorted and weighed. Wet and clumped nest contents were discarded. Twelve boxes were put up again to study the second clutches.

Eggs which did not hatch till the young were a week old, were removed from the nests/boxes and were later examined to ascertain the cause of unhatchability. Young dying within the nests were examined at the Virology and Parasitology Laboratory of the Punjab Agricultural University. Data were analysed using standard parametric and non-parametric statistical methods (Zar, 1984). To examine the effect of laying season, brood number, egg sequence and habitat on reproductive variables, data from nest boxes alone were used. All other breeding parameters were quantified by pooling data from boxes and natural nests.

RESULTS

Breeding season

The breeding activity of the common myna commenced in March and continued till September. Mynas started adding nesting material to nest sites in the first week of March and 15 nest boxes were occupied by 16th March. The first egg was laid on 31st March and the first batch of 4 young hatched on 17th April. The first peak in breeding activity was observed from 15th April to 15th May and the second around 1st July (Fig. 1). Some birds, however, started breeding late, probably because of non-availability of suitable nesting sites. Active nests of this species on electric and telephone poles were found only after June. The first batch of nestlings fledged on 11th May. The last batch of nestlings was observed being fed by parent birds in a natural-hole nest

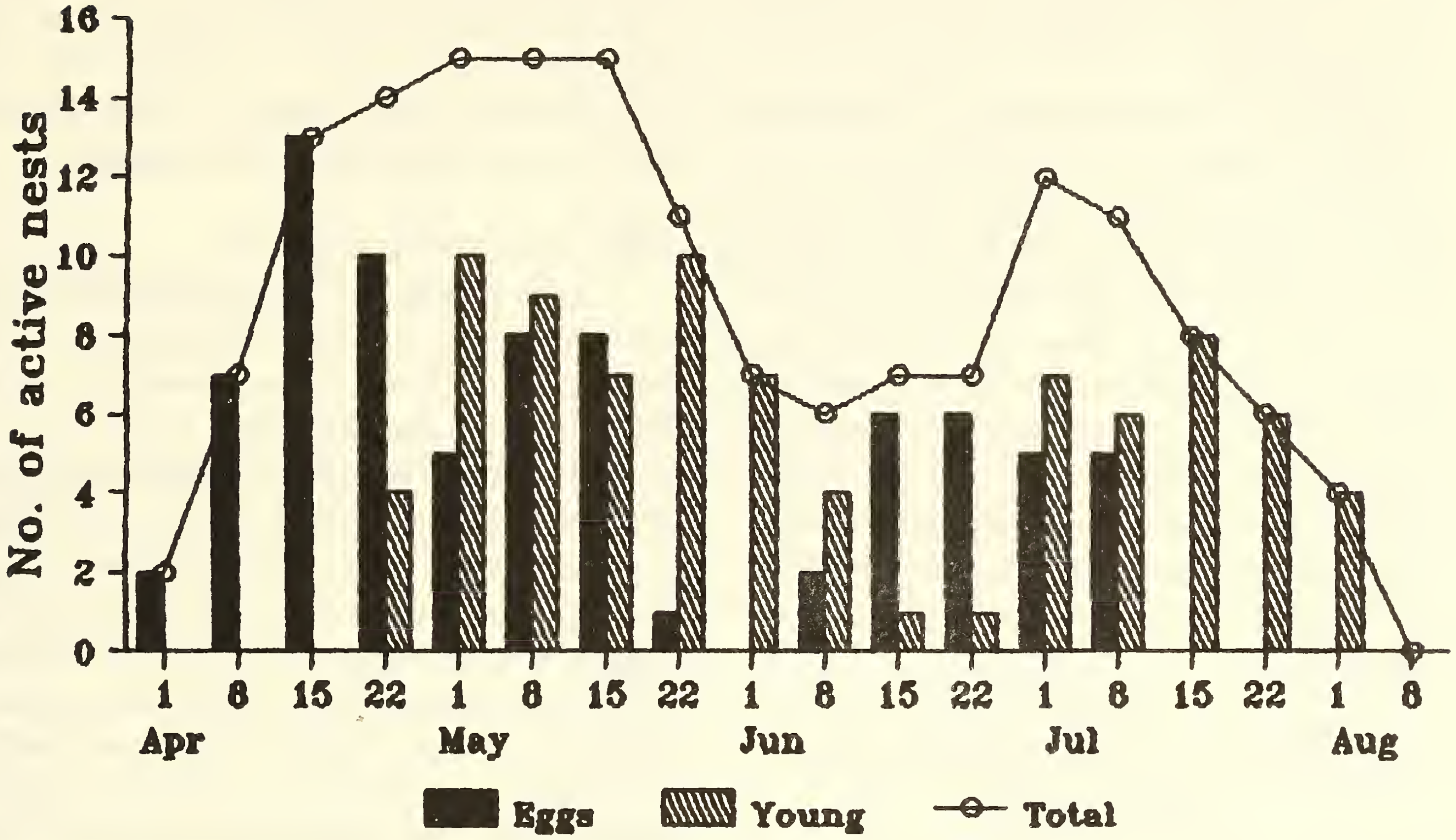

Fig. 1. Pattern of breeding activity of Common Myna *Acridotheres tristis* during 1992

on 27th September, which probably fledged in the beginning of October. Thus, the breeding season in the common myna was considerably long, extending over a period of six months from March to September.

Nesting Material

Nesting birds did not bring nesting material from far off distances. All leaves and twigs found in the nests belonged to the nest tree itself or the adjacent trees. The usual nesting material consisted of twigs and leaves of plants. Twigs and leaves of neem *Azadirachta indica* and dhrek *Melia azedarach* trees, if available nearby, were the most frequently used. Other materials like feathers, paper, plastic bags, sweet wrappers etc., were also found frequently in all nests. Occasionally, materials like snake exuviae, tail of squirrel, bird bones and fish scales were also included.

In 15 nests, whose nesting material was sorted and weighed, twigs and leaves were used in significantly greater quantities than feathers, paper and plastics (One way ANOVA: F=11.84, df = 3,56, $P < 0.0001$, Table 1)

TABLE 1
NESTING MATERIAL IN COMMON MYNA NESTS IN NEST BOXES AND NATURAL NESTS

Nesting Material	Amount (g) (n = 15)
Paper & plastics	$5.33^{a} \pm 1.29$
Feathers	$11.58^{a} \pm 3.55$
Twigs	$49.07^{b} \pm 8.52$
Leaves	$47.63^{b} \pm 9.73$
Difference between material types (ANOVA)	$F = 11.84$ df = 3 & 56 $P = 0.0001$

Figures with same superscripts in a column do not differ significantly (Tukey's multiple range test)

Eggs

Eggs were laid at 24 hr intervals except for three instances where one of the successive eggs was laid at a 48 hr interval. These were oval, longer than broad and turquoise-blue in colour.

The colour turned slightly dull near hatching. Weight of freshly laid eggs ranged from 6.0 to 8.5 g and averaged 7.36 ± 0.10 g (mean ± se, n = 35, Table 2). The last egg appeared comparatively lighter in weight as compared to the first, especially in clutches bigger than 4 eggs. However, differences in the average weight of successive eggs were non-significant (F=0.937, df = 4, 30, P = 0.456; Table 2). The average egg weight in individual clutches ranged from 6.50 ± 0.36 g to 8.23 ± 0.14 g and differed significantly among different females (F = 7.65, df = 8, 26, P < 0.001; Table 2). The length, breadth and volume of 152 eggs of common myna averaged 29.11 ± 1.37 mm, 21.41 ± 0.71 mm and 6.82 ± 0.63 cm^3, respectively.

Table 2

WEIGHT OF EGGS OF COMMON MYNA

Box No.	Weight of eggs (g)					Mean ± se
	1st egg	2nd egg	3rd egg	4th egg	5th egg	
1	7.5	7.0	7.0	broke	6.8	7.08 ± 0.15
2	7.8	8.0	7.8	8.0	—	7.09 ± 0.06
3	7.6	6.2	6.0	6.2	—	6.05 ± 0.36
12	8.0	8.0	8.0	7.0	—	7.75 ± 0.25
13	7.5	7.3	7.0	7.0	6.8	7.12 ± 0.13
22	7.6	7.2	8.2	7.5	—	7.63 ± 0.21
23	7.1	7.0	7.0	6.9	6.9	6.98 ± 0.04
24	—	8.2	8.5	8.0	—	8.23 ± 0.14
27	7.5	7.5	—	—	—	7.05 ± 0.00
Mean ± se	7.58 ± 0.09	7.38 ± 0.21	7.44 ± 0.29	7.23 ± 0.25	6.83 ± 0.03	7.36 ± 0.10 (n=35)

Difference among successive eggs: F = 0.937, df = 4, 30, P = 0.456

Difference among nest boxes: F = 7.65, df = 8, 26, P < 0.001.

Egg size in relation to brood number, laying sequence and laying month

When egg size of the first, second and third broods was compared using one way ANOVA, difference among broods were non-significant for all the three size parameters (Table 3). Similarly, successive eggs of the clutches did not differ significantly in size (Table 4). No differences could be detected in size of eggs laid in April, May and June (Table 5). These analyses suggested that brood number, laying sequence and laying month did not affect egg size.

Effect of habitat on egg size

Data on egg size were available from nest boxes put up in six different habitats, *viz.*, fish farm, poultry farm, shisham woodlot, forestry area, orchards and cultivated fields. One way ANOVA showed no effect of habitat on the length of the eggs, although habitat significantly affected both breadth and volume of eggs (Table 6). Eggs in the poultry farm area were broadest and with biggest volume, followed by those in cultivated fields and orchard. Egg breadth was smallest in shisham woodlot, whereas volume was smallest in shisham woodlot, and at par in forestry area and fish farm. The probable reason for the biggest egg size in poultry farm may be greater abundance of food (scattered poultry feed) available to the laying females in that area.

Clutch size

The clutch size of the common myna varied from 3 to 7 but clutches of 4 and 5 eggs were the most frequent (Fig. 2). Of 52 clutches laid in nest boxes and natural nests, 8 were of 3 eggs, 25 of 4 eggs, 16 of 5 eggs and two of 6 eggs each. Only one clutch in a nest box contained 7 eggs. Clutch size averaged 4.29 ± 0.85 (sd).

Clutch size in relation to brood number, laying season and habitat

Clutch size did not differ significantly among first, second and third broods (Table 7). Some birds started breeding early (beginning of April), whereas the others started late (in June or July). The clutch size in June (3.56 ± 0.13 se, n = 16) did not differ significantly from that in July (3.67 ± 0.33, n = 3, t = 0.33, P > 0.50). So the data of these two months were pooled and taken as of late breeding season. The effect of laying season on clutch size was highly significant,

TABLE 3

EGG SIZE IN RELATION TO BROOD NUMBER IN COMMON MYNA

	Brood number			Difference among broods (df = 2 & 130)
	1 (n = 97)	2 (n = 24)	3 (n = 12)	
Length (mm)	28.87 ± 0.14	29.53 ± 0.34	29.17 ± 0.29	*F* = 2.28 (ns)
Breadth (mm)	21.44 ± 0.07	21.35 ± 0.19	21.31 ± 0.08	*F* = 0.28 (ns)
Volume (cm^3)	6.78 ± 0.06	6.89 ± 0.17	6.76 ± 0.08	*F* = 0.31 (ns)

± figures represent standard error; ns = non-significant

TABLE 4

EGG SIZE IN RELATION TO EGG SEQUENCE IN COMMON MYNA

Egg sequence in clutch	Sample size	Length (mm)	Breadth (mm)	Volume (cm3)
First egg	14	29.09 ± 0.30	21.49 ± 0.18	6.86 ± 0.15
Second egg	14	28.81 ± 0.38	21.30 ± 0.18	6.68 ± 0.17
Third egg	14	29.23 ± 0.44	21.41 ± 0.20	6.86 ± 0.21
Fourth egg	15	28.65 ± 0.35	21.33 ± 0.17	6.66 ± 0.15
Fifth egg	9	28.66 ± 0.43	21.0 0 ± 0.16	6.44 ± 0.15
Sixth egg	3	28.77 ± 1.87	21.20 ± 0.74	6.65 ± 0.84
Difference:				
F-value		0.339	0.604	0.601
(df = 5,63)		ns	ns	ns

± figures represent standard error; ns = non-significant

TABLE 5

SIZE OF COMMON MYNA EGGS IN RELATION TO LAYING SEASON

	Early (April) (n = 78)	Mid (May) (n = 36)	Late (June) (n = 19)	Difference (df = 2, 130)	
				F	*P*
Length (mm)	28.96 ± 1.4	29.07 ± 1.5	29.10 ± 1.15	0.119,	ns
Breadth (mm)	21.39 ± 0.68	21.59 ± 0.68	21,19 ± 0.82	2.135,	ns
Volume (cm^3)	6.77 ± 0.61	6.93 ± 0.71	6.67 ± 0.57	1.200,	ns

± figures represent standard deviation; ns = non-significant

TABLE 6

EFFECT OF HABITAT ON EGG SIZE OF COMMON MYNA

Habitat	No. of eggs	Length (mm)	Breadth (mm)	Volume (cm^3)
Fish farm	64	28.94	21.36^{ab}	6.75^{a}
Poultry farm	8	29.44	22.28^{c}	7.45^{c}
Shisham woodlot	19	28.84	21.17^{a}	6.61^{a}
Forestry area	23	29.73	21.32^{ab}	6.66^{a}
Orchard	15	29.66	21.54^{b}	7.01^{b}
Cultivated field	4	29.38	21.68^{bc}	7.04^{bc}
Difference among habitat (df = 5 & 127)		*F* = 1.075 ns	*F* = 3.47 *P* < 0.006	*F* = 2.96 *P* < 0.02

Figures with same superscripts in a column do not differ significantly (Tukey's multiple range test)

ns = non-significant

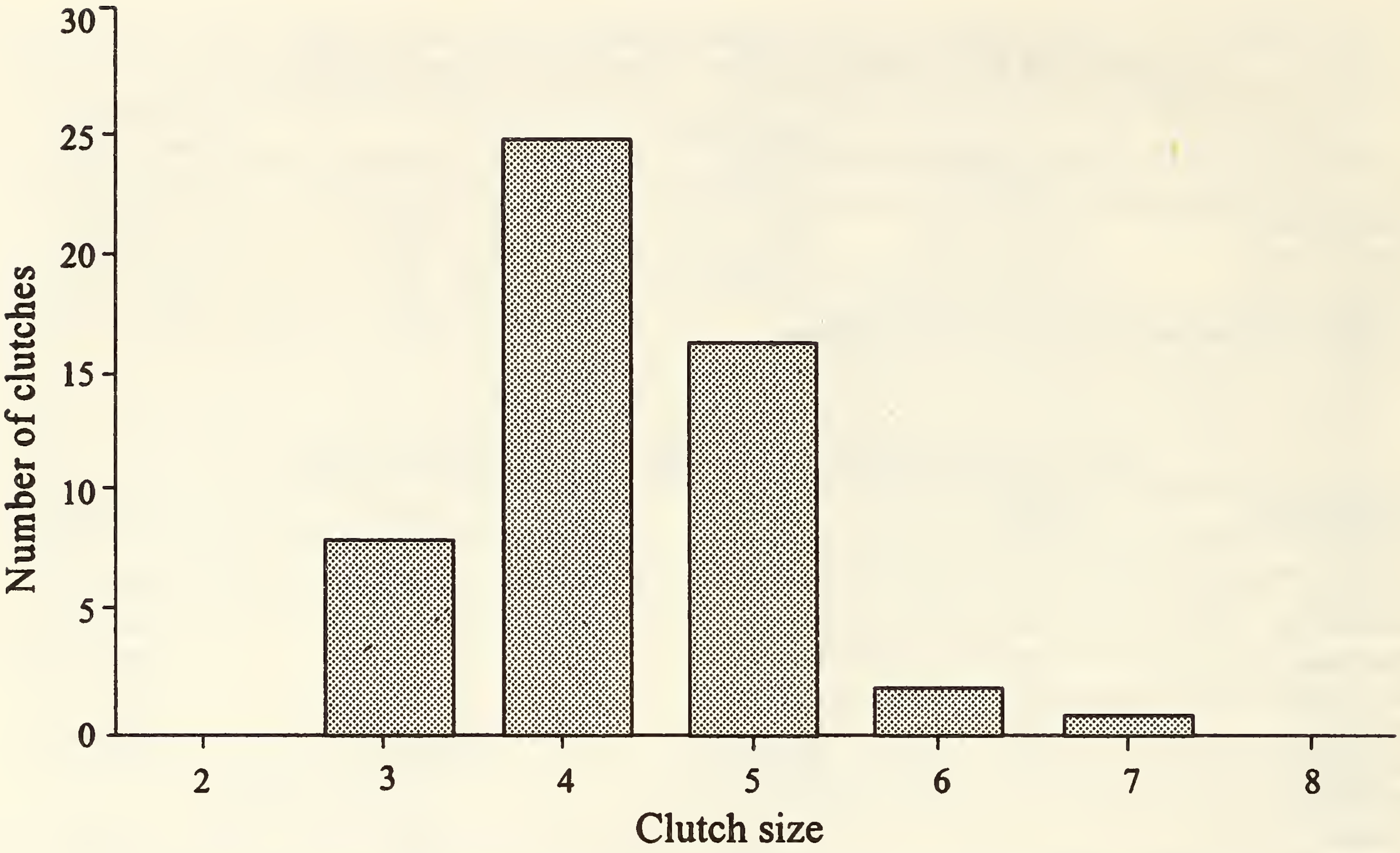

Fig. 2. Frequency of clutch size of Common Myna *Acridotheres tristis* during 1992

TABLE 7
EFFECT OF BROOD NUMBER ON CLUTCH SIZE, NUMBER OF EGGS HATCHED AND NUMBER OF YOUNG FLEDGED IN COMMON MYNA

Brood	Clutch size		No. hatched		No. fledged	
	Mean ± se	n	Mean ± se	n	Mean ± se	n
First	4.46 ± 0.15	37	2.90 ± 0.27	40	1.28 ± 0.18	47
Second	3.92 ± 0.15	12	2.67 ± 0.31	12	1.58 ± 0.28	12
Third	3.67 ± 0.33	3	2.67 ± 0.33	3	2.00 ± 1.00	3
Difference among broods	*F* = 2.916 (df = 2 & 49) ns		*F* = 0.122 (df = 2 & 52) ns		*F* = 0.717 (df = 2 & 59) ns	

showing a steady reduction in average clutch size with the advancement of season (Table 8). There was no significant effect of habitat on clutch size (Table 9).

Incubation period, hatching pattern and hatching success

Data on incubation period (time elapsed between the laying of the last egg of the clutch and hatching of the last young) were available for 15 clutches in nest boxes. The incubation period ranged from 11 to 14 days and averaged 12.73 ± 0.88 (sd) days.

Hatching in 21 clutches indicated an asynchronous pattern. The larger the number of young hatched, the longer was the hatching period. In larger clutches (4-5 eggs), hatching continued for 2-3 days. Two young hatched simultaneously on the first day of hatching in 8 cases, 3 young in 7 cases and 4 young in 2 cases.

Table 8
EFFECT OF LAYING SEASON ON CLUTCH SIZE, NUMBER OF EGGS HATCHED AND NUMBER OF YOUNG FLEDGED IN COMMON MYNA

Laying season	Clutch size		No. hatched		No. fledged	
	Mean ± se	n	Mean ± se	n	Mean ± se	n
Early (April)	$4.84^{c} \pm 0.19$	19	$3.37^{b} \pm 0.35$	19	1.58 ± 0.35	19
Mid (May)	$4.50^{b} \pm 0.15$	12	$3.50^{b} \pm 0.38$	12	1.43 ± 0.27	14
Late (June-July)	$3.58^{a} \pm 0.12$	19	$2.45^{a} \pm 0.26$	20	1.38 ± 0.23	21
Difference	$F = 18.562$		$F = 3.21$		$F = 0.133$	
among seasons	(df = 2 & 47)		(df = 2 & 48)		(df = 2 & 51)	
	$P < 0.0001$		$P < 0.05$		ns	

Figures with same superscripts in a column do not differ significantly (Tukey's multiple range test) ns = non-significant

Table 9
EFFECT OF HABITAT ON CLUTCH SIZE, NUMBER OF EGGS HATCHED AND NUMBER OF YOUNG FLEDGED IN COMMON MYNA

Habitat*	Clutch size		No. hatched		No. fledged	
	Mean ± se	n	Mean ± se	n	Mean ± se	n
Fish farm	4.53 ± 0.29	15	2.60 ± 0.41	15	1.53 ± 0.40	15
Poultry farm	4.00 ± 0.00	2	2.33 ± 1.20	3	0.67 ± 0.67	3
Shisham woodlot	4.50 ± 0.22	6	3.67 ± 0.61	6	1.50 ± 0.50	6
Forestry area	4.22 ± 0.22	9	3.33 ± 0.24	9	2.00 ± 0.33	9
Orchard area	5.00 ± 0.00	3	3.33 ± 0.88	3	2.33 ± 0.33	3
Difference	$F = 0.624$		$F = 0.933$		$F = 0.846$	
among habitats	(df = 4,30)		(df = 4,31)		(df = 4,31)	
	ns		ns		ns	

*Cultivated field area excluded from analysis since only clutch was recorded in this area
ns = non-significant

Table 10
HATCHING SUCCESS AND EGG MORTALITY IN COMMON MYNA (N = 54 NESTS)

	Number	% of total eggs
Total eggs laid	227	
Eggs hatched	150	66.1
Eggs lost	77	33.9
Hatching failure	42	18.5
Predation	22	9.7
Nest desertion	9	4.0
Handling loss	2	0.9
Intraspecific brood parasitism	2	0.9

In the rest of the four clutches, all young hatched at 1-day intervals.

Hatching success was recorded in 54 nests in all. Of 227 eggs laid in these nests, 150 hatched successfully, a hatching success of 66.1% (Table 10).

Egg mortality

Total egg mortality recorded in this study was 33.9%. Hatching failure was the most severe factor claiming 42 (18.5%) eggs (Table 10). Unhatched eggs were retained in nest boxes for such a long period that in five cases they were found intact even after fledging of young. In open natural nests, unhatched eggs were not found 2-4 days after hatching. Altogether, 13 unhatched eggs were examined after breaking the egg shell. Twelve of these eggs were found to be infertile, since no embryo formation was present. In one egg, however, a dead embryo was found in a late stage of development. The major cause of hatching failure, therefore, seemed to be infertility of eggs.

Predation (loss of all eggs and/or young from a nest) accounted for the loss of 22 eggs (9.7%) and was the second most important factor of egg mortality. Two nests were deserted for unknown reasons, leading to the loss of 9 eggs (3.96%). Two eggs (0.9%) were found cracked in a nest box in which intraspecific brood parasitism was recorded, while two eggs (0.9%), one each in two different clutches, were broken accidentally during egg measurements.

The young

The newly hatched pinkish young weighed 5-6 g and were covered with white, woolly, fluffy down feathers along the mid-dorsal line and on two lateral tracts. One patch of down feathers was present behind each eye, one on head and two small patches were visible on the lateral sides. Three rows of black heads of feather pins were visible through the translucent skin on the back and one row on each wing. The eyes were closed and the gape was pale yellow. The claws were soft and cream coloured.

Feather pins of different tracts pierced the skin in the following sequence: alar tract in 2-day old, femoral tract in 3-day old and humeral, caudal, spinal and cephalic tracts in 4-day old young. Eyes started opening 5 days after hatching. Feather pins of the posterior parts of the body were clearly visible and the wings looked quite dark because of very thick alar pins. On the 6th day, crural and capital feather tracts also appeared, alar pins were 2 mm long and eyes fully open in all the young.

One week old young of common myna clearly displayed all the feather tracts, although the pins were yet to open up. Two rows of wing quills had appeared on each wing, the posterior row being 5 mm in length. Remiges and rectrices had developed on the eighth day. The posterior row of remiges started opening at their terminal ends on the ninth day and the whole wing looked like a column of paint brushes placed side to side with their barbs touching the adjacent feathers. In 10-day old young, remiges were 2 cm and rectrices 1 cm long. Small brown feathers looked quite distinct on the dorsal side of the body. On the 11th day, all feathers except those of the capital tract started opening at their terminal ends, and the second row of rectrices also appeared. On the 12th day, all feathers on the body were partially open. The cephalic feather pins, however, opened on the 14th day.

With the full development of feathers, the two weeks old young were quite active. Distinct brown colour on the back was followed in appearance by black on the wings with a white patch on each wing. White colour at the tips of rectrices also became conspicuous with the growth of feathers.

Newly hatched nestlings gained weight rapidly during the first five days after hatching, followed by a steady decrease in growth rate. The young had attained maximum weight at the age of 15 days. Thereafter, the weight showed gradual decrease till fledging. Thus, the growth of young followed a sigmoidal curve (Fig. 3).

Feeding and care of young

Both parents were observed feeding the young. The food was brought at 2-5 min intervals. When both parents brought food simultaneously, only one of them entered the nest while the other waited outside. The parents were never observed removing faecal droppings from the nests, as a result of which a large amount of these were recovered from the nests. Unhatched eggs and some egg shells were also retained in the nests. Even the dead young were not removed. Both parents continued to feed the young for a few days after fledging.

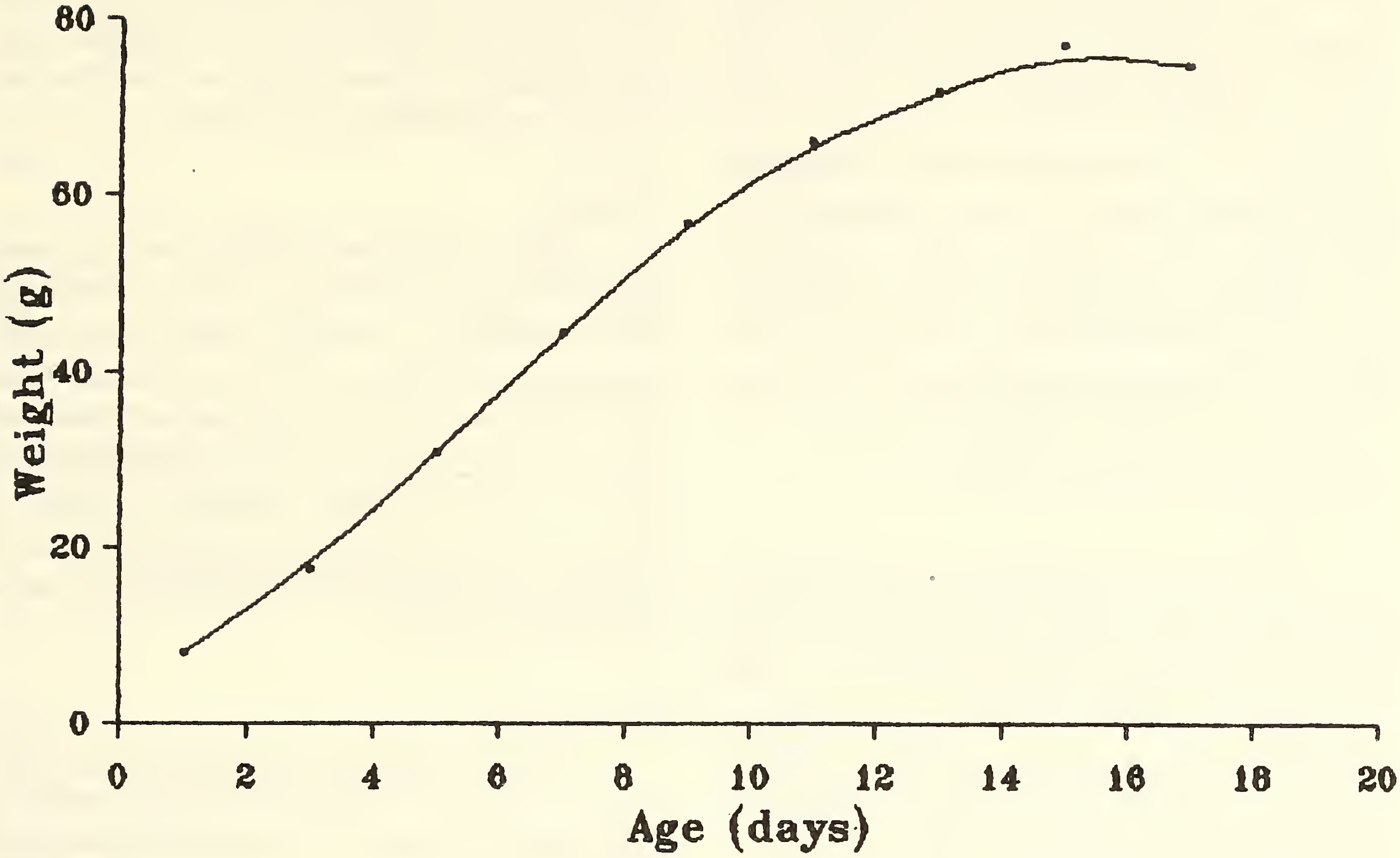

Fig. 3. Weight increase with age in nestlings of Common Myna *Acridotheres tristis* during 1992

Nestling period

The nestling period, i.e., time lapsed between hatching of the first young and fledging of all young in a nest, averaged 21.75 ± 2.38 (sd) days (n = 16) and ranged from 17 to 25 days. Pox-infected unhealthy young spend longer periods in the nests and such cases were not included in calculations.

Nesting success and Nestling mortality

In all, 78 young fledged from 227 eggs laid in 54 nests, a nesting success of 34.4% (Table 11). This means that each nesting pair, on an average, fledged 1.4 young. Seventy-two nestlings were lost to the following mortality factors.

TABLE 11
NESTING SUCCESS AND NESTLING MORTALITY IN COMMON MYNA (N = 54 NESTS)

	Number	% of total eggs	% of young hatched
Total eggs laid	227		
Young hatched	150		
Young fledged	78	34.4	52.0
Young died	72	31.7	48.0
Predation	21	9.3	14.0
Intraspecific rivalry	17	0.5	11.3
Starvation	11	4.9	7.3
Pox virus	8	3.5	5.3
Dust storm	3	1.3	2.0
Unknown reasons	12	5.3	8.0

Pox virus:

Pox virus infected 13 young in 6 broods, of which 5 fledged and 8 died, a nestling mortality of 5.3% (Table 11). The virus was diagnosed by the presence of small tubercles on the naked areas around the eyes and beak. In addition, skin rashes were found on the rest of the body. The plumage of infected young appeared rough and dry with small white patches falling off the skin. With the progress of the virus infection, the eyes were almost completely closed and the young were probably half blind. The infected young did not die quickly but instead stayed on in the nest for 4-10 days more than the average nestling period. The fledging of infected young apparently depended upon the degree of infection, those with comparatively lesser infection could fledge. The virus was diagnosed by the Virology Department of Punjab Agricultural University as "*Acridotheres tristis* pox-virus".

Starvation:

As a result of asynchronous hatching, the developing young were of different sizes and weights. In some cases, the difference in weight of nestlings of the brood soon narrowed down and the young attained almost equal weight and size in a few days. But in others, especially in larger broods, one or two young continued to remain smaller and weaker than their brood mates with very little increase in weight. Such nestlings died in the nest and their death was considered to be due to starvation. Eleven young (4.9% of total eggs laid, 7.3% of eggs hatched) died because of this reason (Table 11).

Intraspecific rivalry:

In four different instances, all young of the brood were found to have been wounded and thrown out of the nests. In all, 17 (11.3%) nestlings died in this way (Table 11). Circumstantial evidence suggested that this was the outcome of intraspecific rivalry.

Predation:

When normal and healthy nestlings were found missing from the nest, it was considered a case of predation. In all the natural open nests, this type of predation led to the destruction of the whole brood. But in nest boxes and hole nests, only one young was found missing at a time. In one box with a single young aged 10 days, a blood smear on the rim of the nest hole indicated predation. In total, 21 (14%) young were lost to predation (Table 11).

Dust storms:

Only one open nest was destroyed in a dust storm killing three young (2% nesting mortality). The inmates of nest boxes and hole nests were not affected by this factor.

Effect of laying season, brood number and habitat on hatching and nesting success

Laying season and brood number did not affect hatching and nesting success (Tables 12 and 13). Also, habitat did not affect these two parameters whether all broods were pooled or only the first broods were analysed separately (Table 14).

TABLE 12

EFFECT OF LAYING SEASON ON HATCHING AND NESTING SUCCESS IN COMMON MYNA

	Hatching success (%)			Nesting success (%)		
	n	Mean ± se	Average rank	n	Mean ± se	Average rank
Early (April)	19	71.14 ± 7.22	25.55	19	31.23 ± 7.29	23.74
Mid (May)	12	77.92 ± 0.08	28.58	11	27.27 ± 7.15	22.09
Late (June-July)	19	71.93 ± 6.22	23.50	19	40.79 ± 7.18	27.95
Difference among seasons (Kruskal-Wallis ANOVA by ranks)	*K-W* statistic = 0.94 *P* = 0.62			*K-W* statistic = 1.48 *P* = 0.48		

Table 13
EFFECT OF BROOD NUMBER ON HATCHING AND NESTING SUCCESS IN COMMON MYNA

Brood	Hatching success (%)			Nesting success (%)		
	n	Mean ± se	Average rank	n	Mean ± se	Average rank
First	38	68.42 ± 5.72	27.68	37	27.43 ± 4.95	24.03
Second	12	69.72 ± 8.26	25.96	12	41.95 ± 7.24	32.04
Third	3	72.22 ± 2.78	22.50	13	50.00 ± 25.0	34.83
Difference (Kruskal-Wallis ANOVA by ranks)	*K-W* statistic = 0.40 *P* = 0.82			*K-W* statistic = 3.73 *P* = 0.16		

Table 14
EFFECT OF HABITAT ON HATCHING AND NESTING SUCCESS IN COMMON MYNA

Habitat	Hatching success (%)			Nesting success (%)		
	n	Mean ± se	Average rank	n	Mean ± se	Average rank
All broods pooled						
Fish farm	15	58.99 ± 7.9	15.10	15	31.66 ± 8.5	17.07
Poultry farm	3	58.33 ± 30.1	17.00	3	16.67 ± 16.7	11.83
Shisham woodlot	6	80.00 ± 11.9	23.42	6	33.33 ± 10.9	17.42
Forestry area	9	80.00 ± 6.0	21.94	9	49.63 ± 8.7	22.94
Orchards	3	66.67 ± 17.6	16.83	3	46.66 ± 6.7	21.17
Difference (Kruskal-Wallis ANOVA by ranks)	*K-W* statistic = 4.09 *P* = 0.394			*K-W* statistic = 3.47 *P* = 0.483		
First broods alone						
Fish farm	7	58.09 ± 13.9	9.64	7	30.47 ± 13.9	10.50
Poultry farm	3	58.33 ± 30.1	9.83	3	16.67 ± 16.7	8.33
Shisham woodlot	4	76.25 ± 17.7	13.13	4	25.00 ± 15.0	9.88
Forestry area	4	80.00 ± 8.2	12.50	4	38.75 ± 15.3	12.38
Orchards	3	66.67 ± 17.6	10.50	3	46.67 ± 6.7	14.50
Difference (Kruskal-Wallis ANOVA by ranks)	*K-W* statistic = 1.198 *P* = 0.878			*K-W* statistic = 2.021 *P* = 0.732		

Comparison of nesting success in open and hole nests in natural sites

Of 14 open nests in natural sites, 9 (64.3%) failed before fledging but 5 (35.7%) were successful, i.e. produced atleast one fledgling. On the contrary, 8 of 10 (80%) hole nests were successful and only 2 (20%) failed. Nesting success, therefore, was significantly greater in hole nests than in open nests (Fisher's exact test, *P* = 0.047)

Discussion

Common mynas in our study initiated breeding activity in March and continued until September, as also mentioned in Dewar (1929), Baker (1933) and Ali and Ripley (1987). The long breeding season of this species allows breeding pairs to raise two or even three successive broods. Although insect food for the nestlings in April-May (when early breeders rear their young) is not as abundant as in the monsoon (July-September), breeding early in the season may be adaptive in acquiring better nesting sites.

Commonly used nesting material included twigs, leaves, feathers, paper, plastics etc., although snake moultings and metallic foil were also used occasionally. Lamba (1963) and Panicker (1980) have also recorded similar materials in common myna nests. In our study, twigs and leaves of neem and dhrek were most frequently used as nesting material. Earlier, Sengupta (1981) found house sparrows *Passer domesticus* using leaves of neem as nesting material in preference to other available vegetation, probably to repel nest arthropods. The use of nest material as insecticidal and anti-pathogenic agents has also been reported for other species of birds (Wimberger, 1984; Clark and Mason, 1985). The relative proportion of other types of material probably depended upon their availability in the vicinity of the nest. For example, in nests in the poultry farm area, a large number of poultry feathers was used, whereas fish scales were found in nests around fish ponds. Use of huge quantity of nesting material in cavity nests and boxes may be important because the common myna does not incubate eggs consistently (Panicker, 1980) and nesting material may help in keeping the nests well insulated. Cavity nesters like parakeets do not use much nesting material but incubate eggs much more consistently as compared to the common myna. Since the common myna breeds in open nests, cavity nesting seems to be a secondary adaptation.

So far, little information was available on the egg weight of the common myna. Panicker (1980) reported egg weight from Delhi and Tamil Nadu. Weight of fresh eggs in our study ranged from 6.0 to 8.5 g and averaged 7.36 ± 0.59 g which is quite close to Panicker (1980; 7.0 g). His results are not comparable to ours because he did not provide variance and sample size. Average egg weight was significantly different among individual clutches, which was probably due to difference in the age or body condition of the laying female.

Average egg size in our study (29.11 x 21.41 mm) was comparable to that reported by Baker (1933) and Lamba (1963) but appeared greater than in Panicker's (1980) study (27.3 x 19.7 mm). Since these authors did not mention the sample sizes and/or variance, statistical comparison of egg size was not possible.Like egg weight, significant differences among clutches in all parameters of egg size suggested that this was different among different females. Both volume and breadth of eggs differed significantly among different habitats, suggesting that these parameters were probably affected by the availability of food. Eggs from nests in poultry farms had the largest volume and breadth, whereas those from shisham woodlot had the smallest values for these parameters. Egg volume was not affected by laying sequence. In other species, however, egg volume may increase as in the least flycatcher *Empidonax minimus* (Briskie and Sealy, 1990) or decrease with laying sequence as in the American crow *Corvus brachyrhynchos* (Ignatiuk and Clark, 1991). Brood number and laying month also did not affect length, breadth and volume of eggs, probably because the food supply available to breeding birds remained the same throughout the breeding season in our area.

Average clutch size (4.29 ± 0.85, n = 52) in our study did not differ significantly from that reported by Lamba (1963) from Tamil Nadu (4.4 ± 0.50, n = 20, t = 0.54, df = 70, ns) and by Panicker (1980) from Delhi (4.6 ± 1.17, n = 3, t = 0.60, df = 53, ns). However, it was significantly greater than that observed by Panicker (1980) in Tamil Nadu (3.45 ± 0.54, n = 11, t 3.13, df = 61, $P < 0.005$). Clutch size tends to increase with increasing latitude in both passerine and non-passerine birds (Lack, 1968). Clutch size in our study area, therefore, should have been greater than that in southern study areas of Lamba (1963) and Panicker (1980). This holds true for comparison with Panicker's (1980) data. Why Lamba (1963) recorded higher clutch size is not clear.

Clutch size of pairs nesting early in the breeding season was greater than those nesting late, which was probably because of the age of egg laying females. Birds breeding for the first time generally start egg laying later than older birds and hence have smaller clutches (Perrins, 1965). In nests where more than one brood was reared, we assumed that these were occupied by the same pairs as evident from their behaviour. Successive clutches in such nests were smaller than the earlier ones. Probably, body condition of the egg laying females is comparatively better when they lay the first than when they lay the second and third broods. Seasonal decline in clutch size has also been reported within age groups in song sparrow *Melospiza melodia* (Hochachka 1990). However, tree creepers *Certhia familiaris* lay largest clutches in the middle of the breeding season (Kuitunen and Aleknonis, 1992).

Average incubation period (12.73 d) in our study was significantly shorter as compared to 17-18 d reported by Lamba (1963). This was because he defined incubation period as the time lag between laying and hatching of the first egg, whereas we measured it as the time elapsed between the laying and hatching of the last egg. Further, the incubation period of birds breeding at higher latitudes is shorter than those breeding at lower latitudes (Lack, 1968). Lamba's study area (Madras), was located at much lower latitude than our study area which may also have contributed to this difference in incubation period. However, incubation period measured in our study is comparable to other studies (Sengupta, 1968; Panicker, 1980).

Hatching success was fairly high (66%) and comparable to Panicker's (1980) study. The major factor of egg loss was hatching failure (18.5%) followed by predation (9.7%). Sterility or infection of the embryo could result in hatching failure. About 70% of eggs in passerines that do not hatch are infected with pathogens such as *Escherichia coli* and *Staphylococcus epidermitis* (Pinowski *et al.* 1991).

The growth in weight of altricial young followed logistic growth curve which is typical for passerines (Ricklefs, 1968). Nestlings attained maximum weight exactly two weeks after hatching, after which they started losing weight. The lesser the number of young in a brood, the more was the average weight, probably because they were better fed than those in larger broods.

One or two nestlings in larger broods were usually underfed and these died in the nests. In birds with asynchoronous hatching, brood size is adjusted according to the availability of food (Ricklefs, 1965). Parents feed the most active members of the brood at priority. But when food is limited, only the largest or the first hatched survive. This behaviour, known as brood reduction, may minimize the amount of effort wasted in feeding extra young and enhance the survival and long-term fitness of parents (Ignatiuk and Clark, 1991). Brood reduction has also been reported in three species of weaverbirds in Punjab (Dhindsa, 1980).

Nestlings period (time lag between hatching of first young and fledging of all young) was 21.75 days. This is comparable to that mentioned in Ali and Ripley (1987), although Lamba (1963) reported it to be 2-3 weeks. Nestling period probably depended upon the number of young in a brood, productivity of the habitat, nest height and age of parents. Nesting success was higher (34%) in our study as compared to Panicker (1980; 28.6%) although his study was confined to those mynas which used tree holes as breeding sites. Laying season, brood number and habitat did not affect hatching and nesting success of the common myna.

Our study is the first to examine the effect of habitat, brood number and laying season on the reproductive output of common mynas. Success of hole nests and open nests of this species has also been compared for the first time. Higher nesting success in hole nests (80%) compared with open nests (35.7%) may be attributed to the following reasons:

1. Hole nests are safer as compared to open nests, because nest contents are out of the reach of avian predators. In our study, none of the open nests of the common myna was successful when there was the nest of house crow *Corvus splendens* on the same tree. The presence of crow nests did not lead to failure of cavity nests of the common myna.

2. Natural calamities like dust storms and heavy rains, which occur frequently during breeding season, do not harm cavity nests. On the contrary, these factors often result in the failure of open nests.

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TAXONOMIC SIGNIFICANCE OF EPIPHALLUS IN SOME INDIAN GRASSHOPPERS (ORTHOPTERA: ACRIDIDAE)[1]

Kharibam Meinodas[2] and Shaikh Adam Shafee[3]

(*With five text-figures*)

Key words: Epiphallus, Orthoptera, Acrididae, taxonomy

The present study comprises of the comparative descriptions and illustrations of epiphalli in 46 species representing 22 genera under 15 tribes belonging to three subfamilies of the family Acrididae. The significance of epiphallus in taxonomy is also discussed.

Introduction

The epiphallus (Fig. 5) is a strongly sclerotised isolated sclerite located on the dorsal surface of the phallic organ that serves to grasp the edge of the female subgenital plate and to fix the phallus firmly during copulation. Dirsh (1956) emphasised the importance of epiphallus in the classification of Acrididae. Further important contributions on epiphallus have been made by Eades *et al.* (1974), Harz (1975), Kevan and Chen (1969) and Kevan *et al.* (1970, 1971, 1972, 1974, 1975). Moreover, Meinodas (1986), Roberts (1941) and Usmani and Shafee (1983) have confirmed the stability and reliability of different parts of the epiphallus in the higher classification of Acrididae.

Material and Methods

To study the epiphallus the apical portion of the abdominal region of preserved male grasshoppers was removed and boiled in a test tube containing 10% KOH solution till the muscles dissolved completely. After washing thoroughly in water, it was dissected under binocular microscope with the help of fine needles to separate the epiphallus. After dehydration in different grades of alcohol, clearing was done in clove oil. The epiphallus was mounted on slides in dorsal view in Canada balsam. The slides were kept in an oven at approximately 40°C for a few days to dry. Drawings were made with the help of camera lucida.

Description

Subfamily Pyrgomorphinae
Tribe Pyrgomorphini

Pyrgomorpha conica (Oliver) (Fig. 1A): Bridge of epiphallus broad; lateral plates with anterior processes slightly developed, posterior processes well developed and directed outwardly, each bearing a small conical upward curving projection; dorsolateral appendages narrow at base, gradually broadened apically; ancorae and lophi absent.

Pyrgomorpha brachycera Kirby (Fig. 1B): Same as in *P. conica* except lateral plates with anterior processes indistinct, curved apical part of posterior processes long; dorsolateral appendages much broadened apically.

Tribe Orthacridini

Neorthacris palnensis (Uvarov) (Fig. 1C): Bridge of epiphallus much broad; lateral plates with well developed anterior processes, posterior

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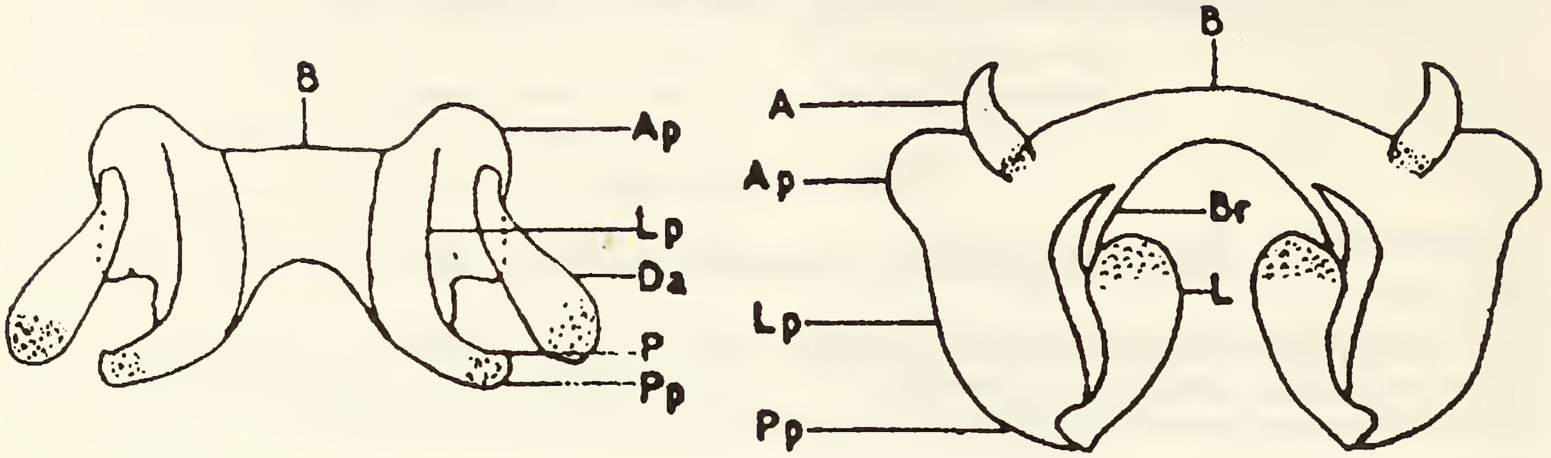

Epiphallus: Pyrgomorphinae. Epiphallus: Acridinae

Fig. 5. Parts of the epiphallus: A. ancorae; Ap. anterior processes; B. bridge; Br. branch of bridge; Da. Dorsolateral appendages; L. Lophi; Lp. Lateral plate; Pp. posterior processes; P. projection of posterior processes.

processes long and straight, each bearing a well developed upward curving conical projection; dorsolateral appendages narrow at base and broad at apex; ancorae and lophi absent.

Neorthacris acuticeps (Bolivar) (Fig. 1D): Bridge of epiphallus with posterior processes diverging, projections directed inwards.

Orthacris maindroni (Bolivar) (Fig. 1E): Bridge of epiphallus narrow with anterior processes well developed, about one half of posterior processes; projections of posterior processes directed outwards.

Tribe Poekilocerini

Poekilocerus pictus (Fabricius) (Fig. 1F): Bridge of epiphallus very narrow; lateral plates with anterior processes slightly developed, posterior processes straight, each bearing a well developed upward curving conical projection; dorsolateral appendages narrow at base and gradually broadened at apex; ancorae and lophi absent.

Tribe Taphronotini

Aularches miliaris (Linnaeus) (Fig. 1G): Bridge of epiphallus narrow medially; lateral plates broadened with anterior processes well developed, posterior processes stout with upward curving conical projections; dorsolateral appendages narrow at base and gradually widened apically; ancorae and lophi absent.

Tribe Chrotogonini

Chrotogonus trachypterus (Blanchard) (Fig. 1H): Bridge of epiphallus uniformly narrow; lateral plates with anterior processes slightly developed, posterior processes triangular, directed outwardly and without projections; dorolateral appendages narrow at base and abruptly rounded at apex; ancorae and lophi absent.

Tribe Atractomorphini

Atractomorpha psittacina (Haan) (Fig. 1I): Epiphallus disc - shaped; anterior margin deeply notched in middle; posterior margin semicircular; lateral plates developed; dorsolateral appendages more or less uniform in width, slightly dilated in the middle; anchorae and lophi absent.

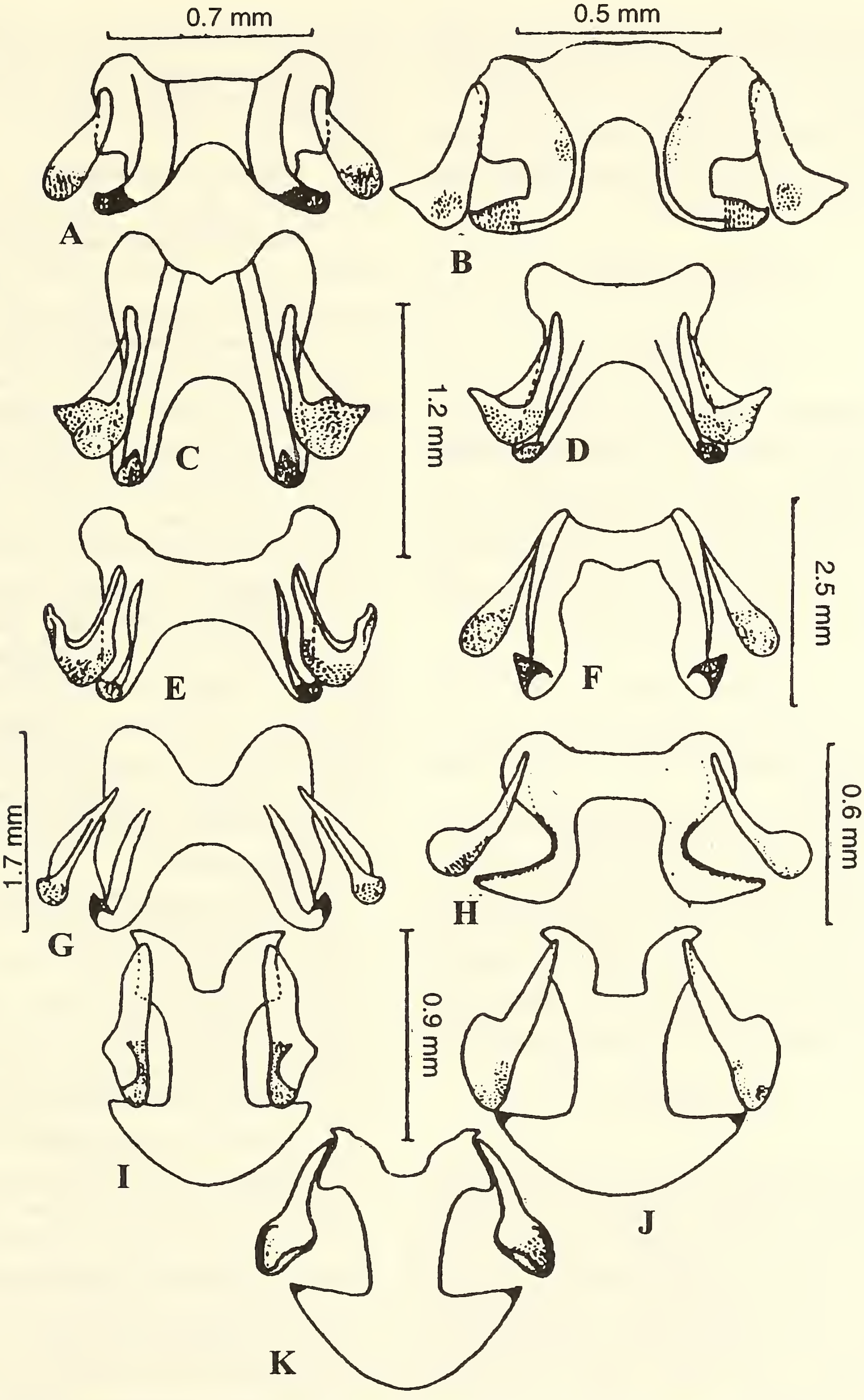
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Fig. 1. Figs. (A-K): A. *Pyrgomorpha conica* (Oliver); B. *P. brachycera Kirby*; C. *Neorthacris palnensis* (Uvarov); D. *N. acuticeps* (Bolivar); E. *Orthacris maindroni* (Bolivar); F. *Poekilocerus pictus* (Fabricius); G. *Aularches miliaris* (Linnaeus); H. *Chrotogonus trachypterus* (Blanchard); I. *Atractomorpha psittacina* (Haan); J. *A. himalayica* Bolivar; K. *A. burri* Bolivar.

Atractomorpha himalayica Bolivar (Fig. 1J): Same as in *A. psittacina* except dorsolateral appendages broader at apex.

Atractomorpha burri Bolivar (Fig. 1K): Same as in *A. psittacina* except dorsolateral appendages which are spatulate.

Subfamily Acridinae

Tribe Truxalini

Truxalis eximia Eichwald (Fig. 2A): Bridge of epiphallus narrow in middle, posterior margin deeply concave; ancorae large, tooth - like, articulated with disc, distance between them about half the distance between posterior processes of lateral plates; outer lophi smaller than inner; dorsolateral appendages absent.

Tribe Acridini

Acrida exaltata (Walker) (Fig. 2B): same as in *T. eximia*.

Phlaeoba infumata Brunner (Fig. 2C): Bridge of epiphallus uniformly narrow, posterior margin deeply concave; ancorae well developed, slightly curved and pointed apically, distance between them more than half the distance between posterior processes of lateral plates; lophi lobe - like; dorsolateral appendages absent.

Tribe Locustini

Gastrimargus africanus (Saussure) (Fig. 2D): Bridge of epiphallus slightly narrow in the middle, posterior margin deeply concave, branches well developed; ancorae long and slightly curved, distance between them more than the distance between posterior processes of the lateral plates; lophi lobe - like; dorsolateral appendages absent.

Oedaleus abruptus (Thunberg) (Fig. 2E): Bridge of epiphallus uniformly narrow, posterior margin slightly concave, branches small and widely spaced; ancorae long, distance between them about one half the distance between posterior processes of the lateral plates; lophi broadened in middle; dorsolateral appendages absent.

Oedaleus nigrofasciatus (De Geer) (Fig. 2F): Almost same as in *O. abruptus*.

Oedaleus senegalensis (Krauss) (Fig. 2G): Same as in *O. abruptus* except lophi which are much dilated, broadened apically.

Aiolopus simulatrix (Walker) (Fig. 2H): Bridge of epiphallus uniformly narrow, posterior margin semicircular, branches well developed and close to each other; ancorae large, distance between them more than half the distance between posterior processes of lateral plates; posterior processes of lateral plates curved inward; lophi sandal-shaped; dorsolateral appendages absent.

Trilophidia annulata (Thunberg) (Fig. 2I): Bridge of epiphallus uniformly narrow, posterior margin U - shaped, branches well developed and near each other; ancorae small and conical, distance between them half the distance between posterior processes of lateral plates; lophi well developed and almost triangular; dorsolateral appendages absent.

Locusta migratoria (Linnaeus) (Fig. 2J): Bridge of epiphallus uniformly broad, posterior margin V - shaped, branches well developed and close to each other; ancorae small, distance between them slightly more than half the distance between posterior processes of lateral plates; lophi lobe - like; dorsolateral appendages absent.

Acrotylus humbertianus Saussure (Fig. 2K): Bridge of epiphallus narrow in the middle with small branches; ancorae long and much curved; distance between them more than the distance between posterior processes of lateral plates; posterior processes of lateral plates with well developed inwardly directed projections; lophi lobiform; dorsolateral appendages absent.

Morphacris fasciata (Thunberg) (Fig. 2L): Bridge of epiphallus uniformly broad, posterior margin U-shaped, branches well developed; ancorae large, distance between them slightly smaller than the distance between posterior

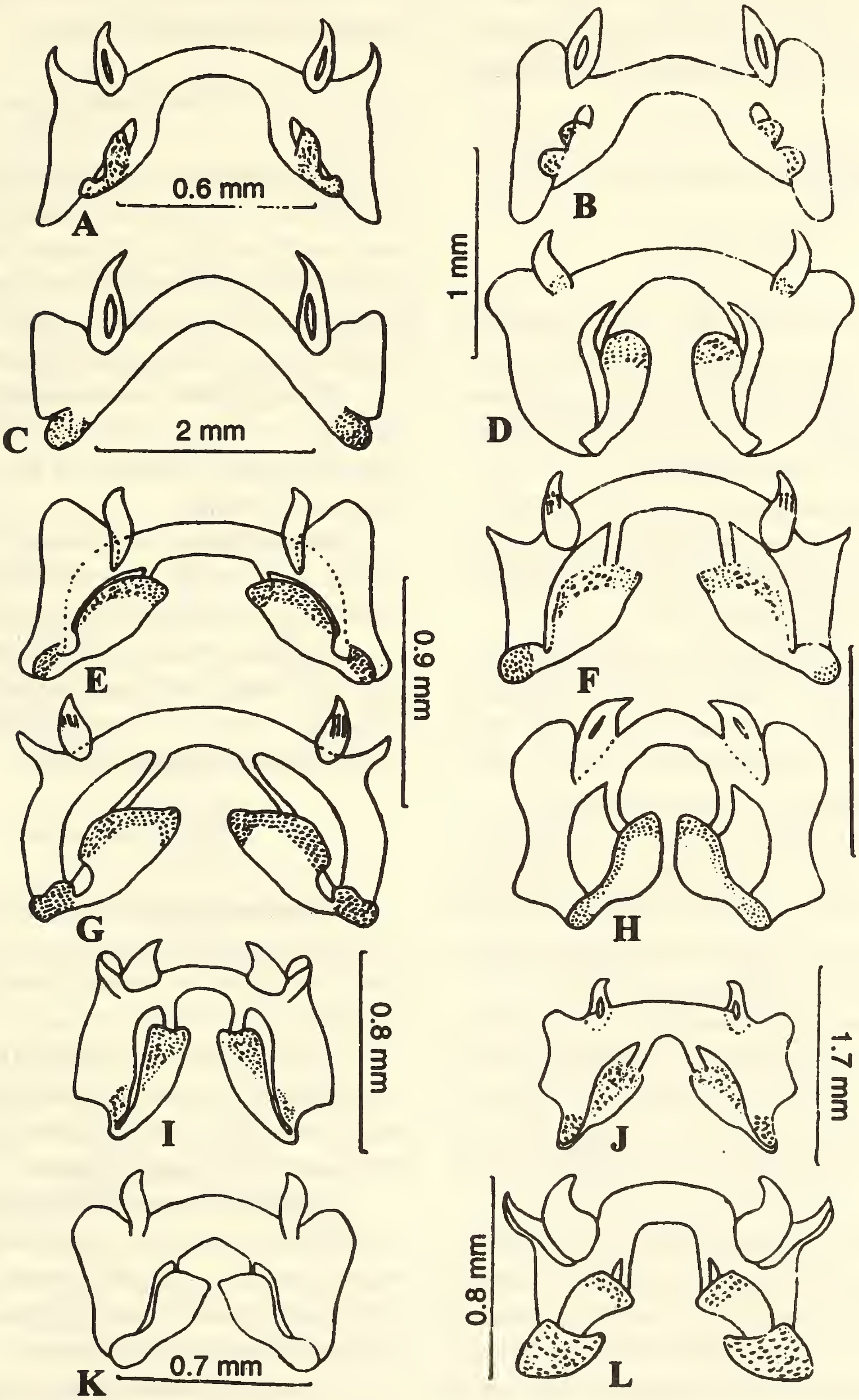
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Fig. 2. Figs. (A-L): A. *Truxalis eximia* (Eichwald); B. *Acrida exaltata* (Walker); C. *Phlaeo infumata* Brunner; D. *Gastrimargus africanus* (Saussure); E. *Oedaleus abruptus* (Thunberg); F. *O. nigrofasciatus* (De Geer); G. *O. senegalensis* (Krauss); H. *Aiolopus simulatrix* (Walker); I. *Trilophidia annulata* (Thunberg); J. *Locusta migratoria* (Linnaeus); K. *Acrotylus humbertianus* Saussure; L.*Morphacris fasciata* (Thunberg).

processes of lateral plates; posterior processes of lateral plates with well developed triangular projections; lophi broad; dorsolateral appendages absent.

Subfamily Catantopinae

Tribe Oxyini

Oxya hyla Serville (Fig. 3A): Bridge of epiphallus divided medially; ancorae absent; lateral plates small without anterior processes, posterior processes small; outer lophi tooth-like; dorsolateral appendages absent.

Oxya intricata (Stal) (Fig. 3B): Same as in *O. hyla,* except bridge of epiphallus with anterior margin medially having a triangular projection; outer lophi broad and plate like.

Oxya fuscovittata (Marschall) (Fig. 3C): Same as in *O. hyla,* except bridge of epiphallus widened medially; lateral plates with well developed anterior and posterior processes; outer lophi broad, plate-like, truncated apically.

Oxya chinensis (Thunberg) (Fig. 3D): Same as in *O. hyla,* except bridge of epiphallus widened medially; lateral plates with well developed anterior processes, posterior processes small; outer lophi triangular and twisted.

Oxya japonica (Thunberg) (Fig. 3E): Same as in *O. hyla,* except bridge of epiphallus broad; lateral plates with well developed anterior processes; outer lophi well developed and contiguous with posterior processes, blunt apically.

Oxya velox (Fabricius) (Fig. 3F): Same as in *O. hyla,* except bridge of epiphallus narrow medially; lateral plates with well developed anterior processes; outer lophi well developed and contiguous with posterior processes, inner lophi broadly triangular.

Gesonula punctifrons (Stal) (Fig. 3G): Bridge of epiphallus narrow, divided medially; ancorae absent; lateral plates with indistinct posterior processes, anterior processes well developed, having long transverse processes; outer lophi toothlike, inner lophi lobe-like; dorsolateral appendages absent.

Tribe Hemiacridini

Hieroglyphus banian (Fabricius) (Fig. 3H): Bridge of epiphallus undivided; ancorae small and toothlike, distance between them slightly more than the distance between posterior processes of lateral plates; lophi bilobate, outer larger than inner; dorsolateral appendages absent.

Hieroglyphus nigrorepletus Bolivar (Fig. 3I): Same as in *H. banian,* except bridge of epiphallus much widened in the middle; lophi broad and platelike.

Hieroglyphus oryzivorus Carl (Fig. 3J): Same as in *H. banian,* except bridge of epiphallus moderately broad; lophi broad and triangular.

Spathosternum prasiniferum (Walker) (Fig. 3K): Bridge of epiphallus uniformly broad, undivided, posterior margin deeply concave; dorsolateral appendages absent.

Tribe Catantopini

Catantops pinguis (Stal) (Fig. 4A): Bridge of epiphallus continuous, ancorae blunt; lophi lobe - like, close to posterior margin of bridge; dorsolateral appendages absent.

Xenocatantops humilis (Serville) (Fig. 4B): Bridge of epiphallus broad medially; ancorae large, truncated; lophi elongated and transverse; dorsolateral appendages absent.

Catantops karnyi Kirby (Fig. 4C): Bridge of epiphallus narrow, posterior margin U - shaped; ancorae straight, conical; lateral plates with anterior and posterior processes small; dorsolateral appendages absent.

Navasia insularis Kirby (Fig. 4D): Bridge of epiphallus narrow in middle, posterior margin U - shaped; ancorae narrow and curved, distance between them slightly more than the distance between posterior processes of lateral plates; lateral plates with anterior processes triangular; lophi small; dorsolateral appendages absent.

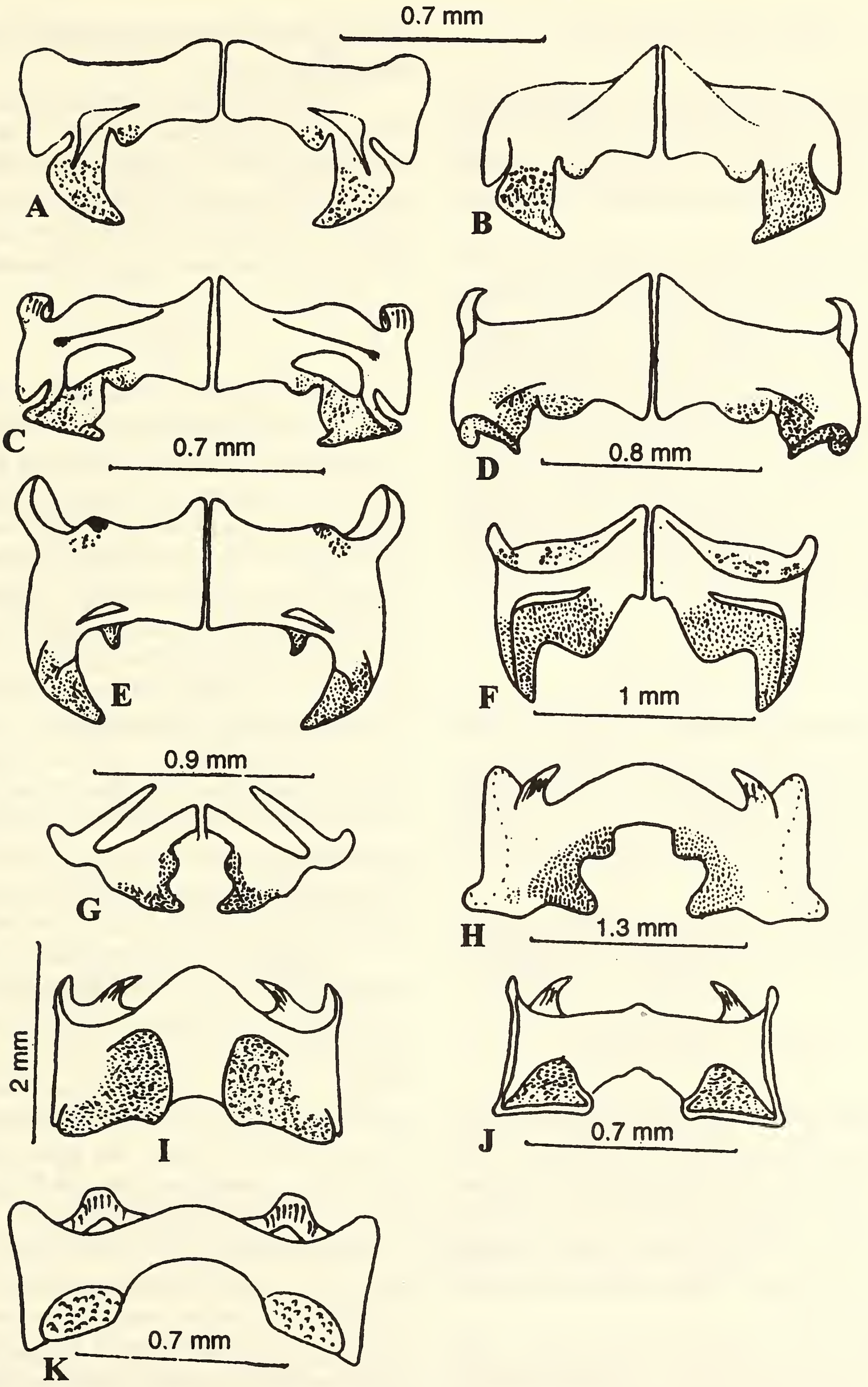
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Fig. 3. Figs. (A-K): A. *Oxya hyla* Serville; B. *O. intricata* (Stal); C. *O. fuscovittata* (Marschall); D. *O. chinensis* (Thunberg); E. *O. japonica* (Thunberg); *F. O. velox* (Fabricius); I. *H. nigrorepletus* Bolivar; J. *H. oryzivorus* Carl; K. *Spathosternum prasiniferum* (Walker).

Tribe Cyrtacanthacridini

Cyrtacanthacris tatarica (Linnaeus) (Fig. 4E): Bridge of epiphallus of uniform width; ancorae absent; posterior processes of lateral plates with conical projections; dorsolateral appendages absent.

Pachyacris violascens (Walker) (Fig. 4F): Bridge of epiphallus narrow in the middle; ancorae small, lateral plates with anterior processes small, posterior processes developed; lophi large; dorsolateral appendages absent.

Patanga succincta (Johansson) (Fig. 4G): Bridge of epiphallus narrow in the middle; ancorae absent; lateral plates with anterior processes very small, posterior processes well developed; lophi large and triangular; dorsolateral appendages absent.

Tribe Coptacridini

Eucoptacra binghamii Uvarov (Fig. 4H): Bridge of epiphallus divided medially; ancorae toothlike, distance between them more than half the distance between posterior processes of lateral plates; outer lophi lobe-like; dorsolateral appendages absent.

Eucoptacra praemorsa (Stal) (Fig. 4I): Same as in *E. binghamii,* except lophi crescent shaped.

Tribe Eyprepocnemidini

Tylotropidius varicornis (Walker) (Fig. 4J): Bridge of epiphallus very narrow in the middle, undivided, posterior margin U - shaped; ancorae small, toothlike, with acute apex; lateral plates with anterior processes small, posterior processes indistinct; lophi large; dorsolateral appendages absent.

Heteracris nobilis (Uvarov) (Fig. 4K): Bridge of epiphallus broad, undivided medially; a groove in the middle present; ancorae well developed; lateral plates with anterior and posterior processes small; outer lophi long and close to posterior margin of bridge; dorsolateral appendages absent.

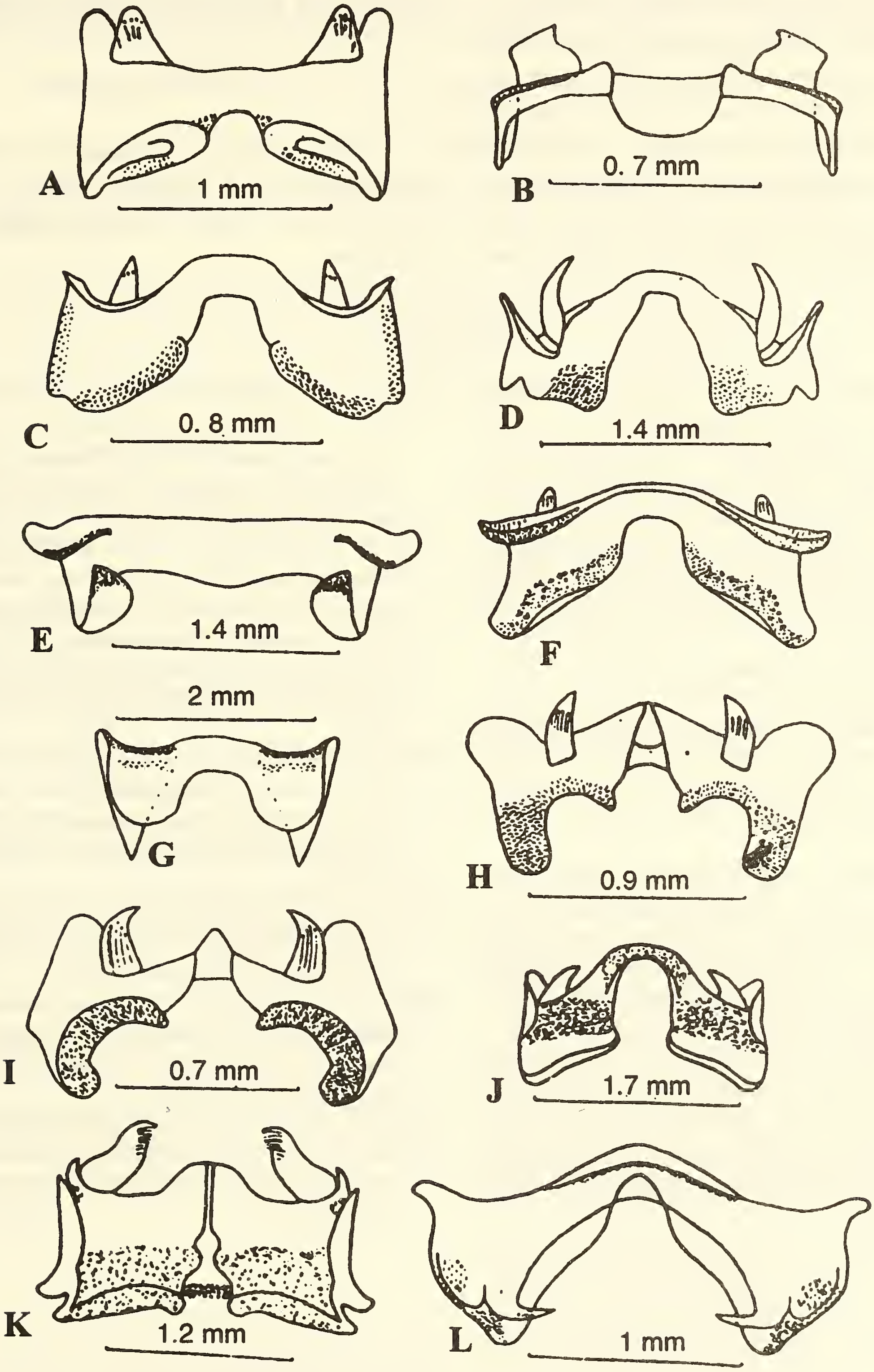
Eyprepocnemis alacris (Serville) (Fig. 4L): Bridge of epiphallus narrow in the middle, undivided, posterior margin semicircular; ancorae small, hooklike, with acute apex and fused with anterior processes of lateral plates, lophi large, lobiform; dorsolateral appendages absent.

DISCUSSION

Dirsh (1956), Kevan *et al.* (1970, 1971, 1974) treated Pyrgomorphidae, Acrididae and Catantopidae as distinct families on the basis of presence or absence of dorsolateral appendages and ancorae on epiphallus. Kevan *et al.* (1975) and Harz (1975) recognised Pyrgomorphini, Orthacridini, Poekilocerini, Taphronotini, Chrotogonini and Atractomorphini as tribes of the subfamily Pyrgomorphinae; Truxalini, Acridini, Locustini as tribes of the subfamily Acridinae; Oxyini, Hemiacridini, Catantopini, Cyrtacanthacridini, Coptacridini and Eyprepocnemidini as tribes of the subfamily Catantopinae on the basis of the modification of the phallic structures. Eades *et al.* (1974) regarded Atractomorphini as a separate tribe only on the basis of the anchorlike form of the epiphallus.

Similarly, in the present study, dorsolateral appendages ("dorsolateral appendices of epiphallus" of Dirsh, 1956) are present in Pyrgomorphinae (Fig. 1, A-K) and these are absent in the remaining subfamilies i.e. Acridinae (Figs. 2, A-L) and Catantopinae (Figs. 3, A-K, 4A-L). These are good subfamilial characters. Ancorae are absent in Pyrgomorphini (Figs. 1, A-K), Oxyni (Figs. 3, A-G) and Cyrtacanthacridini (Figs. 4 A, E-G) and well developed in the remaining tribes. Bridge of epiphallus is divided medially in Oxyini (Figs. 3, A-G), Coptacridini (Figs. 4, H-I) and undivided in the remaining tribes. These are reliable tribe characters.

It can be concluded that hump - shaped, bridge - shaped, unilobate or bilobate condition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1.7 mm
K
1.2 mm
L
1 mm

Fig. 4. Figs. (A-L): A. *Catantops pinguis* (Stal); B. *Xenocatantops humilis* (Serville); C. *Catatops karnyi* Kirby; D. *Navasia insularis* Kirby; E. *Cyrtacanthacris tatarica* (Linnaeus); F. *Pachyacris violascens* (Walker); G. *Patanga succincta* (Johansson); H. *Eucoptacra binghamii* Uvarov; I. *E. praemorsa* (Stal); J. *Tylotropidius varicornis* (Walker); K. *Heteracris nobilis* (Uvarov); L. *Eyprepocnemis alacris* (Serville).

of lophi of epiphallus and presence or absence of branch of bridge connecting lophi with bridge are significant generic characters. Moreover, size of anterior and posterior lobes of lophi of epiphallus, and the size and shape of ancorae are stable specific characters. Comparative study of such phallic structures can provide stable taxonomic values for subfamilies, tribes, genera and species within the family Acrididae.

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LARGE HERONRIES IN KUTCH AND THE NESTING OF GLOSSY IBIS *PLEGADIS FALCINELLUS* AT LUNA JHEEL, KUTCH, GUJARAT, INDIA[1]

J. K. Tiwari[2] and Asad R. Rahmani[2,3]

(*With two text-figures*)

Key words: Glossy Ibis, *Plegadis falcinellus*, Ciconiiformes, breeding, Rann of Kutch, India

While conducting various surveys for the grassland birds in Banni and other areas of Kutch, we came across some large heronries, and discovered breeding glossy ibis *Plegadis falcinellus*. We counted upto 250 nests of glossy ibis in 1992 and 500 in 1994. No breeding of glossy ibis and other wading birds took place during the drought year of 1993.

Introduction

The glossy ibis *Plegadis falcinellus* is a widely distributed water bird, found in Asia, Europe, Africa, Central America and on many islands (Hancock *et al.* 1992). Ali and Ripley (1983) and Roberts (1991) describe it as partly resident and nomadic, and partly a winter visitor. In the Indian subcontinent so far, the breeding of glossy ibis has been reported in Sind, Pakistan, Oudh (north India), Orissa, Assam and Manipur (Ali, 1945). All these records are very old and do not mention details of the exact location of nesting, year of nesting and the number of nests. In the nonbreeding season, the glossy ibis can be seen in large flocks in many flooded portions of Banni grassland and on the edge of the Great and the Little Rann of Kutch. In the winter of 1992-94, some 500 to 700 glossy ibis were seen by us at Vakeria-Dhand, Chhari-Dhand, Servo-Dhand, Kheerjog-Dhand, Abhada-Jheel and Mokar-Jheel (*Dhand* in Sindhi-Kutchi means a shallow seasonal lake).

Study Area

In June 1992, our field station was set up at Fulay village to study the ecology of Banni grasslands, Kutch dist. Gujarat. The first large heronry was discovered by us in September 1992 near Luna village. Luna village is located on the northernmost limit of the Banni grassland. Many low-lying villages in this region are inundated by heavy monsoons, causing them to be seasonally abandoned. Such habitations in the Banni region are locally known as *"jheel* villages" (jheel = shallow wetland).

Survey Results

While conducting various surveys for grassland birds in the Banni and other areas of Kutch, we discovered four large heronries (Fig 1.), described below:

A. **Luna Heronry**: On 30th September 1992 at Luna village on the edge of the Great Rann of Kutch, about 80 km northwest of Bhuj, we came across a huge heronry where eight species of birds were nesting, the glossy ibis being one of them (Tiwari 1993) (Table 1 for other species). From September 1992 to December 1994, the Luna heronry was visited many times. Owing to poor rainfall in 1993 (60 mm only), the Luna jheel was dry, hence nesting birds were absent from the heronry, but during two good rainfall years, a large number of nests were recorded at Luna on 30th September, 1992, and 7th August, 1994. Many nests at that time had grown up young ones. We therefore presume that the nest building and incubation must have

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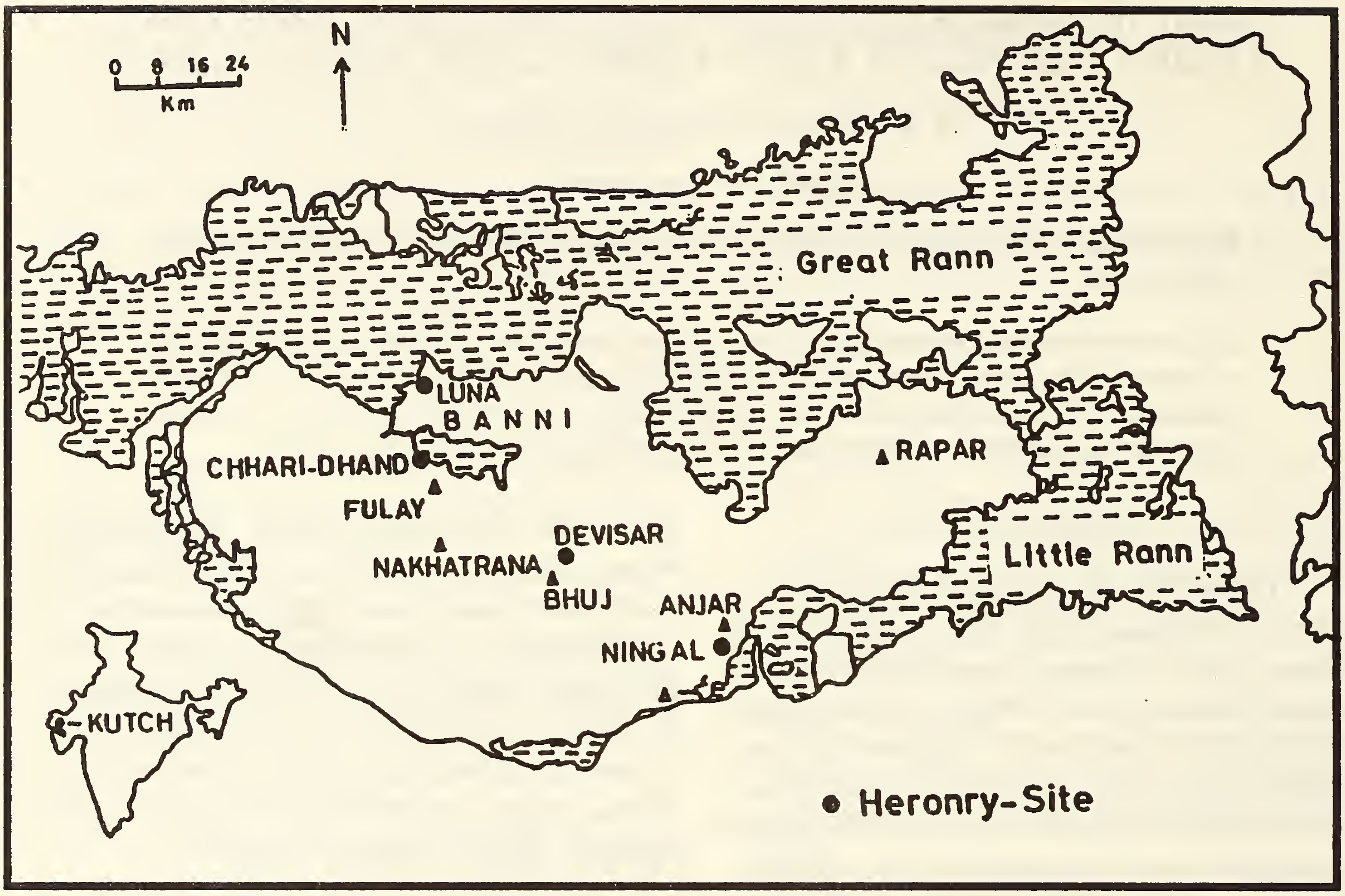

Fig. 1. Large Heronries of Kutch dist. Gujarat (India)

started in June or July. The fledglings leave the nest by the end of September or October.

The Luna heronry is reputed to be about 50 years old. According to the villagers, after a good monsoon, the glossy ibis breeds regularly in Luna, along with other species. The discovery of such a large breeding colony of glossy ibis is a record from western India.

Most of the nests were found on mesquite *Prosopis juliflora* and *Acacia nilotica* trees. During good rainfall years, water depth in Luna varies from 0.5 m to 2.5 m. Snails, fishes and frogs are abundant in the jheel. Besides fish and macro-invertebrates, the glossy ibises were observed feeding snails to their nestlings.

Upto five nests were seen on any one tree. The nearest nesting neighbours of the glossy ibis were mostly cattle egret *Bubulcus ibis* or night heron *Nycticorax nycticorax*. In August 1994, torrential rains caused heavy damage to the nesting colony at Luna, but the colony was re-established by the birds within a period of about 20 days. The year 1994 received unusually heavy rainfall (1250 mm), whereas the mean annual rainfall for Kutch dist. is 340 mm.

Nestlings of glossy ibis, about one to three weeks old, have a pinkish rose coloured bill with two black bands on it, one broad band in the middle and one on top. The overall body coloration of the young bird is faded blackish brown. The number of young birds in the nest varied from one to three. House crows *Corvus splendens* were observed preying on the nestlings of waterbirds including about one to two weeks old young ones of the glossy ibis.

A large spoonbill colony was found in Luna jheel in 1994, but it was located about half a kilometre from the main heronry. The reason for this could be that 1 to 2 m high bushes, which are utilised by the spoonbills for nesting, were present

TABLE 1
LUNA HERONRY* NEST DETAILS

Species	Nest 1992	Young 1992	Nest 1993	Nest 1994	Young 1994
Rainfall	(640 mm)		(60 mm)	(1250 mm)	
Common name					
Cattle Egret	3000	5500	Nil	6500	8000
Little Egret	50	90	"	250	350
Median Egret	35	75	"	150	200
Night Heron	50	100	"	25	35
Little Cormorant	220	500	"	50	80
Spoonbill	5	10	"	400	650
White Ibis	40	100	"	50	80
Glossy Ibis	250	500	"	500	725
Total	3650	6875	Nil	7925	10120

* Most numbers are approximate

only in that area.

B. **Chhari-Dhand**: This colony was in a seasonal saucer-shaped natural depression in the Banni grassland which fills with water during rains. The area and depth of this wetland varies with rainfall. The maximum area recorded is around 80 sq. km after 640 mm rains in 1992. During the monsoon, the entire area around Chhari-Dhand gets flooded and the excess water then flows down to the Great Rann of Kutch. Thick mats of *Eleocharis* reeds, 1 to 2 m high grow on the outer fringes of Chhari-Dhand. The depth of this wetland varies from 0.5 to 1.5 m. *Tamarix* sp. and *Salvadora persica* bushes grow scattered in the wetland area. About 3,600 nests of five species of waterbirds were estimated in 1994. We used boats to reach the breeding colony and on each bush/tree counted the nests.

C. **Devisar**: This is a shallow 4 sq. km lake near Rudramata Dam, 15 km from Bhuj, the district headquarters of Kutch. Five species of egrets and herons nest here in the month of August and September after a well set monsoon. We estimated 800 to 1000 nests in September 1992.

D. **Ningal**: S. N. Varu, a keen ornithologist of Bhuj, found a heronry near Anjar village where painted storks *Mycteria leucocephala* nest regularly after a good monsoon. In September 1992, he estimated up to 200 nests.

TABLE 2
CHHARI-DHAND NEST DETAILS

Species	No of Nests	No of Young
Purple Heron	35	40
Night Heron	50	65
Spoonbill	500	850
Cattle Egret	1500	2500
Little Cormorant	1500	2600
Total	3585	6055

DISCUSSION

Nesting success and rainfall: In the study area, nesting of wading birds depends clearly on the amount of rainfall. This seems to be particularly true for the glossy ibis. There are no perennial natural waterbodies in the saline desert of Kutch. The major colony sites in Kutch are located either near dams and reservoirs or in the monsoon flooding areas in the Banni grassland and on the edge of the Great Rann of Kutch. The rainfall pattern of Kutch is very irregular and erratic, and so is the nesting of wading birds. During three years of our study period, no heronry was seen during the drought year (Fig 2).

We found that water-dependent species such as the glossy ibis, painted stork, egrets and herons breed only during good monsoon years.

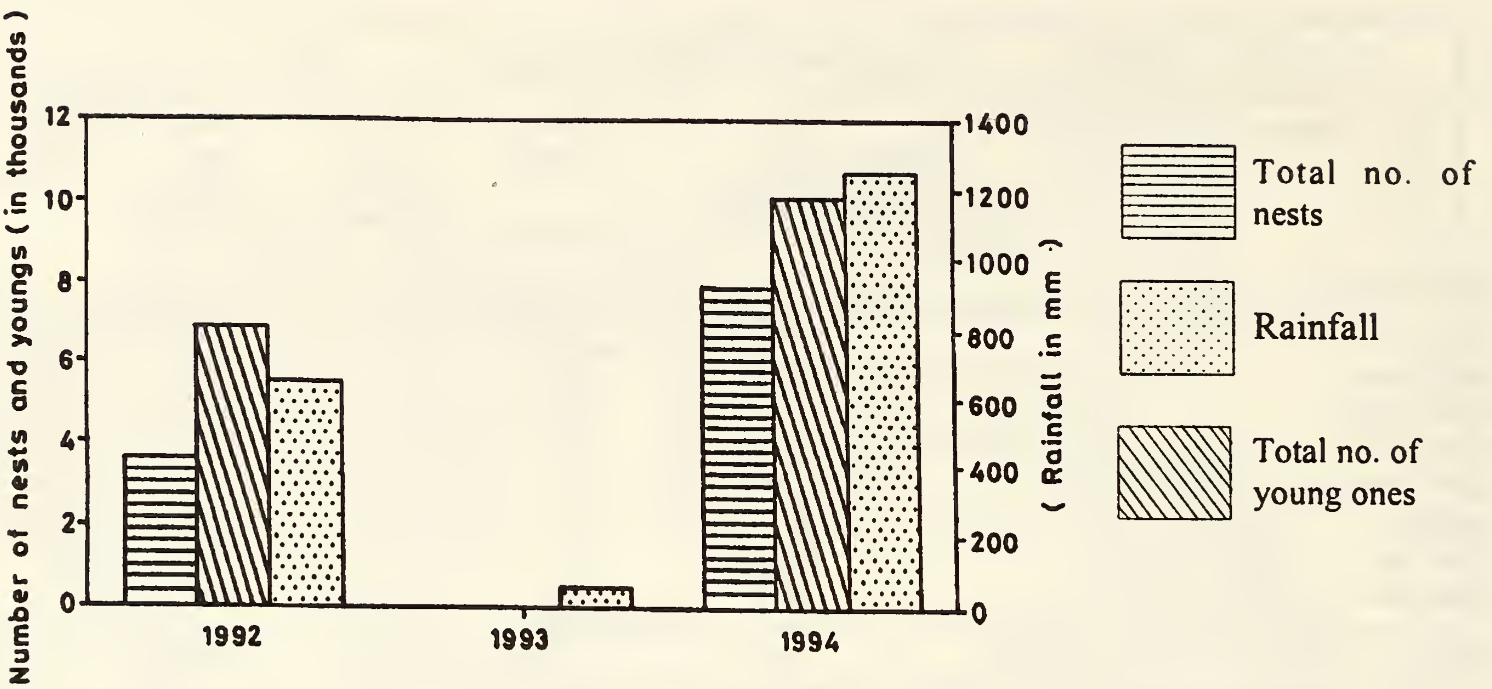

Fig. 2. Rainfall pattern and nesting of heronry birds at Luna jheel

Strict protection of the bird colonies is afforded by Luna villagers to the heronry. A few years ago a pastoral community from a neighbouring village used to collect young birds for food, an activity which has now stopped. Large scale commercial fishing without licence at Chhari-Dhand is today the main threat to the nesting birds, because it depletes their food. Pumping of water from Devisar and Ningal sites by farmers creates further problems for the nesting birds because this reduces the extent of the feeding areas. According to the villagers, the painted stork used to nest in large numbers in Luna heronry, but now it has stopped. The reason could be the collection of the young ones in the past.

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HOST PLANT RANGE OF ARBOREAL NESTING RED ANTS IN KANYAKUMARI DISTRICT OF TAMIL NADU (INDIA)[1]

V. KUMARESAN[2]

Key words: Host range, red weaver ants, *Oecophylla smaragdina.*

In Kanyakumari dist. 68 species of flowering plants harbour Asian red weaver ants (*Oecophylla smaragdina* Fb.). The frequency of arboreal nesting on these plants has been analysed in this article.

INTRODUCTION

Kanyakumari, the southernmost district of India, lies between 8° 5' - 8° 30' N lat. and between 77° 10' - 77° 36' E long., covering an area of 1,684 sq. km. Of this, 446 sq. km are forests. All areas, except forests, were surveyed during this study.

Red weaver ants are found from India to Queensland, Australia and Solomon Islands (Lokkers, 1986.) It is generally believed that the Asian red weaver ants live in broad leaved evergreen trees (Bingham, 1903). The present study reveals that they also live on deciduous trees, small leaved trees and on some climbers.

Oecophylla smaragdina is a major pest of some fruit trees and minor pest of some other trees. It reduces the yield or causes difficulties during harvesting and management of farms. Even though it does not cause much direct damage to the crops, some of its associates are harmful. However, *O. Smaragdina* has been known to protect some plants from harmful insects (J.D. Tothill *et al.* 1930). The present investigation illustrates the frequency of nesting of arboreal red weaver ants in various species of flowering plants in the study area.

MATERIAL AND METHODS

Field trips were frequently conducted to different parts of the study area, and plants were observed for nests of red weaver ants. The plants with red ants were floristically studied and dried specimens were deposited at the Department of Botany, Vivekananda College, Agasteeswaram. The frequency of nesting of red ants, average number of nests per plant and average number of leaves found in the nests were recorded. (Table 1).

RESULTS AND DISCUSSION

Table 1 shows the frequency of nesting of red weaver ants on the plants of the study area. Red weaver ants build their nests on 68 species of flowering plants in the area. High frequency of nesting was noticed on *Calophyllum inophyllum, Thespesia populnea, Anacardium occidentale, Pithecellobium dulce* and *Erythrina variegata.*

The frequency of occurrence of nests of red weaver ants was low (20%) in *Polyalthia longifolia, Hibiscus rosa - sinensis, Citrus acida, Citrus medica, Murraya koenigii, Azadirachta indica, Gliricidia maculata, Tamarindus indica, Albizia lebbeck, Lawsonia inermis, Carica papaya, Ixora coccinea, Eupatorium glandulosum, Nerium odorum, Thevetia peruviana, Ervatamia divaricata, Plumeria rubra, Brugmansia suaveolens, Manihot esculenta, Manihot glaziovii, Phyllanthus acidus, Jatropha glandulifera, J. curcas, Ricinus communis, Ficus religiosa, F. benghalensis, Morus australis, Musa paradisiaca, Areca catechu, Borassus flabellifer, Cocos nucifera* and in *Caryota urens.* In cultivated species the

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TABLE 1
HOST RANGE OF RED WEAVER ANTS IN KANYAKUMARI DISTRICT

No.	Name of plant	Family *	No. of plants studied	No. of plants with red ants	No. of nests per plant	No. of leaves per nest●
1.	*Annona squamosa* L.	Annonaceae	410	98	3-15	3-7
2.	*Annona muricata* L.	Annonaceae	63	30	1-24	3-6
3.	*Polyalthia longifolia* (Sonn.) Thwaites	Annonaceae	72	9	3-21	1-8
4.	*Tinospora cordifolia* (Wild.) Hook f. & Thomson	Menispermaceae	74	22	1-7	1-5
5.	*Craeteva roxburghii* R. Br.	Capparaceae	20	4	4-23	1-3
6.	*Calophyllum inophyllum* L.	Clusiaceae	210	163	>50	3-7
7.	*Thespesia populnea* (L.) Sol. ex. Curr. Serr.	Malvaceae	412	213	>50	1-4
8.	*Hibiscus rosa - sinensis* L.	Malvaceae	672	18	3-11	3-10
9.	*Hibiscus tiliaceus* L.	Malvaceae	231	81	>50	1-3
10.	*Bombax ceiba* L.	Bombacaceae	11	6	7-43	1-4
11.	*Eriodendron pentandrum* (L.) Kurz	Bombacaceae	43	20	23-44	1-3
12.	*Citrus acida* L.	Rutaceae	232	39	3-18	3-9
13.	*Citrus medica* L.	Rutaceae	212	42	3-12	3-8
14.	*Murraya koenigii* (L.) Spreng.	Rutaceae	79	12	3-11	1-7
15.	*Aegle marmelose* (L.) Curr. Serr.	Rutaceae	12	3	>50	1-3
16.	*Limonia acidissima* L.	Rutaceae	11	4	>50	3-7
17.	*Azadirachta indica* Adr. Juss.	Meliaceae	223	17	3-31	3-8
18.	*Anacardium occidentale* (L.)	Anacardiaceae	129	73	>50	3-8
19.	*Mangifera indica* L.	Anacardiaceae	413	123	>50	4-7
20.	*Erythrina variegata* L.	Papilionoideae	79	42	24	1
21.	*Pongamia glabra* Vent.	Papilionoideae	34	9	9-49	1-3
22.	*Gliricidia maculata* (Sleudel.) Kunth	Papilionoideae	642	21	5-21	1-3
23.	*Abrus precatorius* L.	Papilionoideae	33	7	7-49	1-3
24.	*Tamarindus indica* L.	Caesalpinioideae	112	1	19	3-7
25.	*Cassia fistula* L.	Caesalpinioideae	12	3	11-27	3-7
26.	*Cassia surattensis* Burm. f.	Caesalpinioideae	9	4	19-26	3-7
27.	*Cassia senna* L. var. senna,.	Caesalpinioideae	42	9	9-31	2-6
28.	*Pithecellobium dulce* (Roxb.) Benth	Mimosoideae	73	63	>50	7-23
29.	*Albizia lebbeck* (L.) Benth	Mimosoideae	213	31	38-47	31-3
30.	*Prosopis juliflora* (SW). DC	Mimosoideae	1172	130	7-21	5-17
31.	*Terminalia catappa* L.	Combretaceae	43	11	>50	1-3
32.	*Syzygium jambolanum* (Lam.) DC.	Myrtaceae	42	17	20-49	3-7
33.	*Psidium guajava* L.	Myrtaceae	110	24	3-40	1-3
34.	*Lawsonia inermis* L.	Lythraceae	79	8	1-13	3-8
35.	*Carica papaya* L.	Caricaceae	413	2	1-2	1
36.	*Coccinia grandis* (L.) J. Voigt	Cucurbitaceae	23	7	1-7	1-3
37.	*Morinda coreia* Buch-Ham.	Rubiaceae	342	84	7-43	4-9

TABLE 1 *(contd.)*

HOST RANGE OF RED WEAVER ANTS IN KANYAKUMARI DISTRICT

No.	Name of plant	Family *	No. of plants studied	No. of plants with red ants	No. of nests per plant	No. of leaves per nest●
38.	*Ixora coccinea* L.	Rubiaceae	173	13	1-12	1-7
39.	*Eupatorium glandulosum* Kunth.	Asteraceae	173	13	1-9	1-5
40.	*Manilkara zapota* (L.) P. Royen	Sapotaceae	27	9	7-32	3-8
41.	*Madhuca longifolia* (J. Koening) Macbr.	Sapotaceae	12	4	7-48	3-7
42.	*Nerium odorum*	Apocynaceae	302	23	3-17	3-11
43.	*Thevetia peruviana* pers.	Apocynaceae	89	13	7-23	3-11
44.	*Ervatamia divaricata* (L.) Burkill.	Apocynaceae	74	3	3-43	3-7
45.	*Plumeria rubra* L.	Apocynaceae	31	3	3-10	1-3
46.	*Pergularia daemia* (Forsskal) Chiov.	Asclepiadaceae	132	51	1-7	3-6
47.	*Cosmostigma racemosum* (Roxb.) Vight	Asclepiadaceae	112	37	1-7	3-6
48.	*Brugmansia suaveolens* (Willd.) Bercht & J.S. Presl	Solanaceae	141	9	1-8	1-3
49.	*Vitex altissima* L.f.	Verbenaceae	74	21	1-9	2-7
50.	*Piper nigrum* L.	Piperaceae	43	9	1-13	1-3
51.	*Loranthus elasticus* Desr.	Loranthaceae	43	12	1-3	2-4
52.	*Manihot esculenta* Crantz.	Euphorbiaceae	1730	127	1-4	1-3
53.	*Manihot glaziovii* Muell. Arg.	Euphorbiaceae	127	4	>50	1-7
54.	*Phyllanthus acidus* (L.) Skeels.	Euphorbiaceae	37	6	3-19	1-3
55.	*Jatropha glandulifera* Roxb.	Euphorbiaceae	218	9	1-6	1-4
56.	*Jatropha curcas* L.	Euphorbiaceae	461	29	1-8	1-3
57.	*Exoecaria robusta* Hook f.	Euphorbiaceae	39	11	1-10	1-3
58.	*Ricinus communis* L.	Euphorbiaceae	128	18	1-19	1-3
59.	*Artocarpus heterophyllus* Lam	Moraceae	99	41	>50	1-7
60.	*Artocarpus incisus* L.F.	Moraceae	73	18	>50	1
61.	*Ficus religiosa* L.	Moraceae	29	2	7-21	1-5
62.	*Ficus benghalensis* L.	Moraceae	63	1	27	1-3
63.	*Morus australis* Poiret.	Moraceae	179	7	1-9	1-5
64.	*Musa paradisiaca* L.	Musaceae	1129	12	1-4	▲
65.	*Areca catechu* L.	Arecaceae	743	79	1-7	+
66.	*Borassus flabellifer* L.	Arecaceae	142	13	1-9	+
67.	*Cocos nucifera* L.	Arecaceae	275	19	1-7	+
68.	*Caryota urens* L.	Arecaceae	27	1	4	+

* Arranged according to *An Excursion Flora of Central Tamilnadu, India.*

▲ Leaf axil, leaf foldings and in bunches.

+ Leaf axil, inflorescence axis, basal portion of leaflets and in bunches.

● In old nests.

frequency of nesting was poor due to frequent human interference during cultivation. Nesting of red weaver ants on cultivated plants indicated poor management of the plants. Nests were seen on *Azadirachta indica, Albizia lebbeck, Carica papaya, Manihot esculenta, Musa paradisiaca* and *Caryota urens* when they were growing near trees with red weaver ants.

It is generally believed that the red weaver ants live in broad leaved evergreen trees (Bingham, 1903), as observed in this study. However, the occurrence of weaver ants was not limited to broad leaved and evergreen trees. Plants with small leaves such as *Pithecolobium dulce* and *Tamarindus indica* also harboured the ants. The frequency of occurrence is higher in *P. dulce* than *T. indica*. The weaver ants inhabited *T. indica* only when the tree was growing in close association with other trees with dense population of the ants. The frequency was low in *Azadirachta indica*, which might be due to the presence of azadirachtin in its leaves. However, no investigation was made to test this.

Evergreen species were more suitable for nesting than deciduous plants. The red weaver ants were observed in deciduous plants such as *Bombax ceiba, Eriodendron pentandrum, Ficus religiosa* and *F. benghalensis*, but the frequency was low. The frequency was low in *F. religiosa* and *F. benghalensis* even if they were growing by other plants with dense population of weaver ants.

Over 80% of the plants inhabited by weaver ants had leaves with smooth surface and with poorly developed epidermal hairs. Dense epidermal hairs on leaves hamper the free movement of weaver ants and thereby reduce the frequency of nesting.

There are several reports of the occurrence of red weavers ants on cultivated species such as coconut (Tothill *et al.* 1930), date palm (Debach, 1974), *Citrus* spp. *Annona reticulata* and *Eugenia caryophyllus* (Hill, 1983), jack tree, cashew, litchi and mango (Seshagiri Rao, 1972), arecanut palm (Kumaresan, 1994). The present study added some more plants to the list. *Murraya koenigii, Hibiscus rosa-sinensis. Annona squamosa, Lawsonia inermis, Morinda coreia, Carica papaya, Ixora coccinea, Nerium odorum, Ervatamia divaricata, Plumeria rubra, Ricinus communis, Phyllanthus acidus,' Musa paradisiaca, Borassus flabellifer,* and *Caryota urens* were new records. Lack of proper management and the presence of infested trees nearby might be the reason for occurrence of weaver ants on these plants.

Even though in recent years red weaver ants have been used as biological agents to kill insect pests of plants, they have been considered as major or minor pests for some crop plants, because they spread some pests like coffee green scales (Hill, 1983).

The spatial separation of the population of weaver ants and plant species might also be a reason why the ants did not build nests on some plants. So it was difficult to identify the species which were not preferred by weaver ants in the study area. Artificial introduction of weaver ants on such plants may give full information regarding host plant preference by red weaver ants.

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INTERSPECIFIC ASSOCIATION OF JACANAS (*HYDROPHASIANUS CHIRURGUS* AND *METOPIDIUS INDICUS*) AND THE ROLE OF HABITAT[1]

N.K. Ramachandran[2]

(*With five text-figures*)

Key words: *Metopidius indicus, Hydrophasianus chirurgus,* interspecific association, habitat similarity, spatial affinity, flocking.

The interactions of the pheasant-tailed jacana *Hydrophasianus chirurgus* and the bronzewinged jacana *Metopidius indicus* with other avian species were studied in a tropical monsoonal wetland in Bharatpur, Rajasthan, India. All together 25 and 29 species of birds were recorded in the proximity of the pheasant-tailed and the bronzewinged jacanas respectively. The pattern of occurrence of the pheasant-tailed and the bronzewinged jacanas with all other avian species was non-random and the nature (direction) of association was characterized as negative, because the frequency of occurrence of jacanas with the other avian species was fewer than their frequency of sighting alone. Season-wise data on bronzewinged jacana also showed non-random pattern and negative association. The role of habitat preference of both the species of jacana and their associated species was studied to determine the nature of their association. Those species which were similar to bronzewinged jacana in their habitat preference had lesser degree of association (spatial affinity) with it because the habitat patches were available in plenty. No predation on adult of both species occurred, except on the eggs of the pheasant-tailed jacana by the marsh harrier (*Circus aeruginosus*) during the study period. The agnostic behaviour of both the species of jacanas and the importance of flocking in the pheasant-tailed jacana as an anti-predatory strategy have also been discussed.

INTRODUCTION

The three broader categories of interspecific association, namely negative, positive and none, and assumed to be the response of a species to its abiotic and biotic factors (Ludwig and Reynolds 1988). The positive association between two species may result from a common response to environmental factors, a behavioural (social) cohesiveness between the species or from a behavioural or ecological repulsion from other areas forcing individuals to co-occupy the same general sets of conditions. Negative associations, on the other hand, may result from differences in habitat preference, behavioural exclusion or repulsion, or effect of past population histories (Pielou 1972; Hubalek 1982).

Studies on the interspecific association among birds in India are very few (Vijayan 1984; Rahmani and Manakadan 1987). In jacana species, interspecific grooming and possible mutualistic interaction of wattled jacana with Capybara *Hydrochoerus hydrochaeris* was reported (Marcus 1985). To date, there is no systematic study on the interactions of jacanas with other avian species. Therefore, a study was carried out for a period of three years since 1985 with the objective of recording, quantifying and

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characterising their interactions with other avian species.

STUDY AREA

The study was conducted in Keoladeo National Park, Bharatpur, a man-modified wetland studied in the Indogangetic plains. The Park is situated between 27° 7.6' and 27° 12.2' N, and 77° 29.5' and 77° 33.0' E in Rajasthan. The total area of the Park is 29 sq. km and out of this 8.5 sq. km is covered by water during the years of normal rainfall and water supply. The aquatic portion of the Park has been divided into various unequal compartments or blocks by means of dykes (Fig. 1). The aquatic and semi-aquatic plants provide the Park with spatial heterogenity which is very important for supporting and maintaining diverse avifauna. 115 species of aquatic birds have been recorded from this area (Ramachandran 1993). The Park receives water annually from a reservoir - Ajan bund, situated about 500 m south of the Park.

METHODOLOGY

Observations were made walking along the dykes using binoculars at different times of the day to cover various activities of the species. Habitats or vegetation patches were distinguished using the dominant vegetation. These vegetation patches were considered as the natural sampling units or discrete habitable units (Pielou 1977). When the area of the vegetation patch was very large (>10 m^2), then observations were made within a 10 m radius of the jacana. This situation arose only in the case of a superabundant species of grass *Paspalum distichum*. All the species found along with jacanas in each vegetation patch were counted and recorded. The habitat type and activity were also recorded for all the species within the sampling unit.

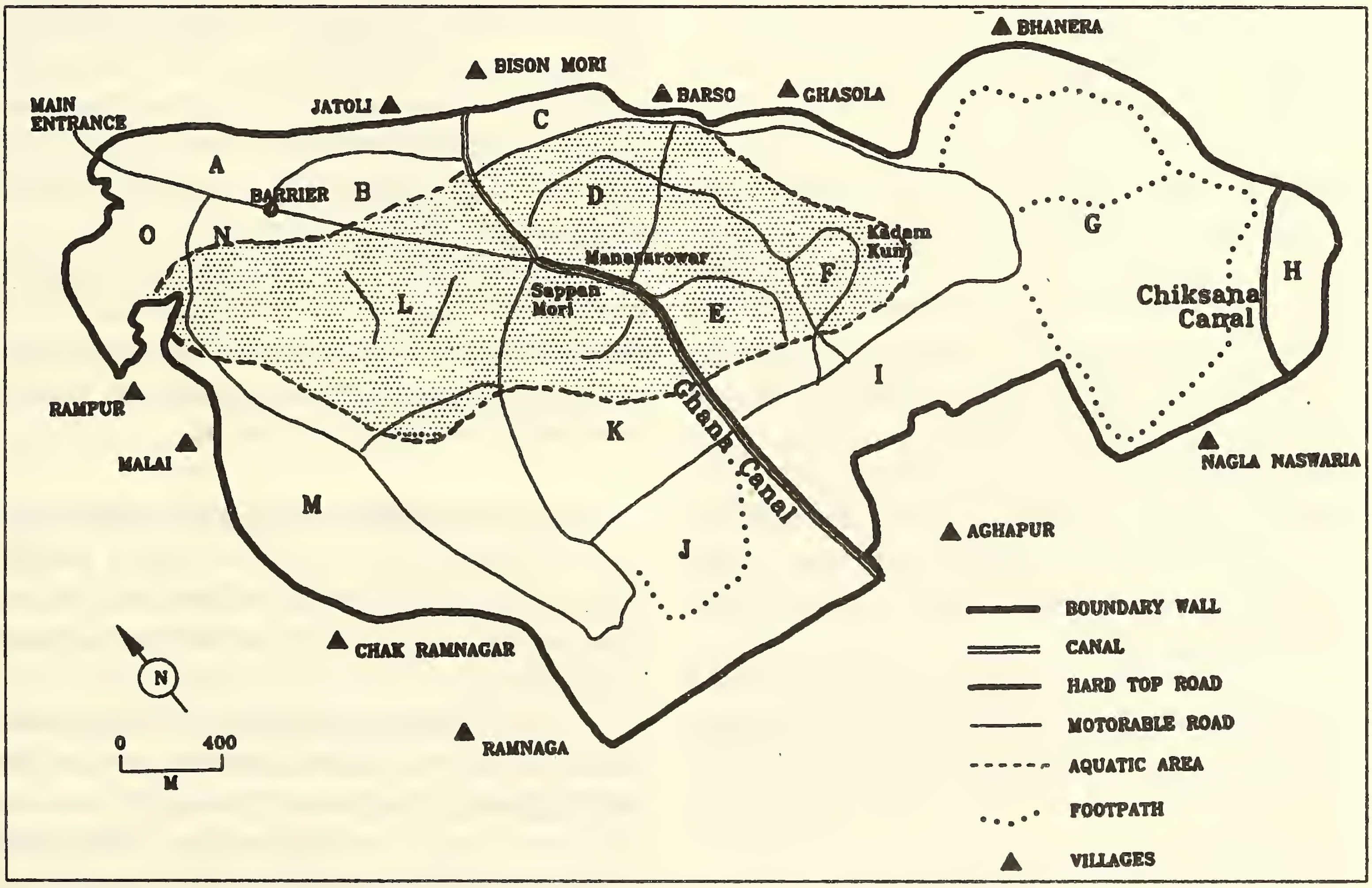
BHANERA
BISON MORI
MAIN ENTRANCE
JATOLI
BARSO
GHASOLA
C
A
BARRIER
B
D
O
N
Kadam Kunj
G
Mansarowar
Sappan Mori
L
E
F
H
Chiksana Canal
I
RAMPUR
K
Ghana Canal
MALAI
NAGLA NASWARIA
M
AGHAPUR
J
CHAK RAMNAGAR
N
0
400
M
RAMNAGA
BOUNDARY WALL
CANAL
HARD TOP ROAD
MOTORABLE ROAD
AQUATIC AREA
FOOTPATH
VILLAGES

Fig. 1. Map of Keoladeo National Park, Bharatpur, Rajasthan, a man-modified wetland

The habitat similarity and spatial affinity were computed. The spatial affinity is a measure of how often two species occur together. This is a measure of association or congregation or temporary grouping of individuals in a foraging area.

STATISTICAL ANALYSIS

To test the hypothesis that the pattern of occurrence of jacanas with or without other species is random, a chi-square test was carried out (Sokal and Rohlf 1981). Once the pattern is proved non-random, the type of interaction was attributed as positive or negative, based on the frequency in both classes. Positive nature was attributed when the frequency of the jacana occurring with a particular species was greater than when it was without the same species. Similarly negative nature was attributed when the case was in the reverse. Data were pooled into three seasons, namely summer (March, April, May and June) monsoon (July, August, September and October) and winter (November, December, January and February) in the case of the bronzewinged jacana. This was done to account for the status of the associated species (i.e. migratory, local resident and locally moving resident). The seasonal break-up of data was done only for the bronzewinged because they occurred through all the seasons, whereas the pheasant-tailed occurred only in monsoon and winter and hence no seasonal treatment of data was attempted. Those species which occurred less than five times are also included in the analysis to represent all the species, although their inclusion is not allowed on statistical grounds (Greig-Smith 1983).

The spatial affinity or the degree of association and the similarity in habitat utilization pattern of jacana and the associated species were expressed as an index of similarity (Bray and Curtis 1957).

$$\text{Similarity index} = 2\,W / (A + B)$$

where W is the sum of the lesser values of abundance in the two species compared, A and B are the sum of abundances of each species. The value of similarity ranges from 0 (for no similarity) to 1 (for complete similarity). In spatial affinity analysis each sighting is treated as such, so that the influence of their spatial pattern within the habitat can be accounted for. In order to examine the role of habitat preference of jacanas and the associated species in their association, their habitat preference was compared by pooling the data habitat-wise and calculating the similarity.

RESULTS

Association of the Pheasant-tailed Jacana:

The pheasant-tailed was present in good numbers only during the monsoon and winter of 1986 and 1987, hence data collected only during those periods were taken for analysis. Even during those seasons their population was not as high as in previous years. Therefore, the pattern of association derived from the data may not be conclusive. Nevertheless, it indicates the trend. On the whole 198 observations were made and a total of 25 species were recorded with the pheasant-tailed jacana (Table 1).

Association of the pheasant-tailed jacana with all other species was non-random, and in all cases frequency of occurrence with each species was less than that of without those species, thus the association was negative (Table 1).

Spatial affinity and habitat similarity:

The pond heron *Ardeola grayii* has the highest affinity followed by cattle egret *Bubulcus ibis*. Another 13 species did not have any affinity at all (Fig. 2).

The habitat use pattern of the pheasant-tailed jacana was more similar to that of the greylag goose *Anser anser* followed by common teal *Anas crecca*, coot *Fulica atra*, little grebe *Podiceps ruficollis* and the bronzewinged jacana (Fig. 2). Among the rest, while a group of species

TABLE 1

SPECIES RECORDED ALONG WITH THE PHEASANT-TAILED JACANA AND THE CHI-SQUARE ANALYSIS FOR TESTING THE NULL HYPOTHESES THAT THE PATTERN OF THEIR OCCURRENCE WITH AND WITHOUT OTHER AVIAN SPECIES IS RANDOM. EXPECTED FREQUENCY = 99.

Associated avian species		Status	Frequency of occurrence of pheasant-tailed Jacana		Ch2*
Common Name	Scientific Name		With other species	Without species	
Large Egret	*Ardea alba*	R	3	195	186.18
Pintail	*Anas acuta*	M	10	188	160.02
Greylag Goose	*Anser anser*	M	1	197	194.02
Grey Heron	*Ardea cinerea*	R	11	187	156.44
Shoveller	*Anas clypeata*	M	16	182	139.17
Common Teal	*Anas crecca*	M	11	187	156.44
Pond Heron	*Ardeola grayii*	R	6	192	174.72
Purple Heron	*Ardea pupurea*	R	4	194	182.32
Spotbill	*Anas poecilorhyncha*	R	3	195	186.18
Gadwall	*Anas strepera*	M	4	194	182.32
Cattle Egret	*Bubulcus ibis*	R	1	197	194.02
Marsh Harrier	*Circus aeruginosus*	M	2	196	190.08
Lesser Whistling Teal	*Dendrocygna javanica*	R	1	197	194.02
Median Egret	*Egretta intermedia*	R	9	189	163.63
Coot	*Fulica atra*	M	26	172	107.65
Indian Moorhen	*Gallinula chloropus*	R	5	193	178.5
Siberian Crane	*Grus leucogeranus*	M	1	197	194.02
Blackwinged Stilt	*Himantopus himantopus*	M	1	197	194.02
Pallas's Fishing Eagle	*Haliaeetus leucoryphus*	M	1	197	194.02
Bronzewinged Jacana	*Metopidius indicus*	R	30	168	96.18
Cotton Teal	*Nettapus coromandelianus*	R	8	190	167.29
Purple Moorhen	*Porphyrio porphyrio*	R	6	192	174.72
Little Grebe	*Podiceps ruficollis*	R	3	195	186.18
Wood Sandpiper	*Tringa glareola*	M	2	176	119.77
Whitetailed Lapwing	*Vanellus leucurus*	M	1	197	194.02

* $Chi^2 > Chi^2_{0.05}$ and hence all null hypotheses are rejected.
R = Resident; M = Migrant

whose values ranged from 0.06 to 0.01 showed very little similarity, another group showed no similarity at all.

Agnostic interactions of the Pheasant-tailed Jacana:

The marsh harrier *Circus aeruginosus* was the main predator of the pheasant-tailed jacana during 1988, preying mainly on the eggs. During 1986 and 1987, pheasant-tailed jacana were not breeding inside the Park and their population was also low. Hence the intensity of predatory interactions was also less.

During 1986, pheasant-tailed jacana foraged in flocks of eight to thirteen. Being a polyandrous species, it has to form groups to facilitate breeding. The grouping or flocking is also an anti-predatory tactic and has been reported in many bird species (Page and Whitacre 1975, Kenward 1978, Bertram 1980). The pheasant-tailed becomes alert on the advance of a raptor, usually from the alarm calls and the subsequent evading flights of another pheasant-tailed or member of any associated species feeding in the vicinity. The pheasant-tailed, being in the vicinity of other species, benefited in getting early warnings.

On hearing or seeing the warnings either from the member of the same species or from other species of birds in the vicinity, jacanas

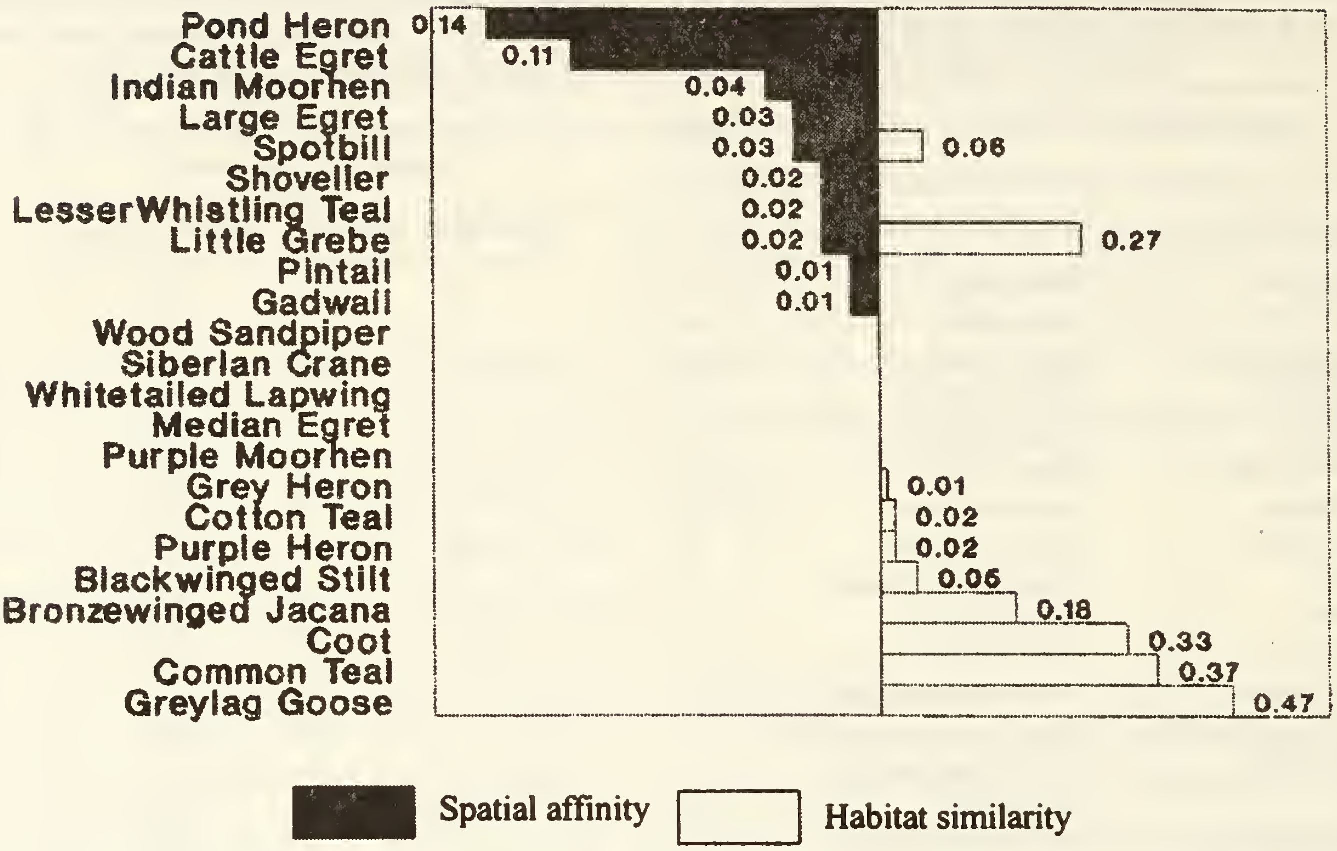

Fig. 2. Spatial affinity and habitat similarity of different avian species with pheasant-tailed jacana

always made aerial escape. They remained on the wing for a while and later settled in the same place or in another patch.

Association of the Bronzewinged Jacana with other species:

Altogether 29 species were sighted along with the bronzewinged jacana during the period of study (Table 2). The number of bird species sighted along with the bronzewinged jacana did not vary much during winter and monsoon, being 24 and 22 respectively, whereas in summer it did vary considerably. The majority of species associated with jacana were resident in all the three seasons. Only seven species were sighted along with the bronzewinged jacana during summer, out of which the wood sandpiper was the only migrant which usually leaves the wintering ground very late (Table 1). The decrease in number during summer was due to the following factors: (1) all the migratory species left the park towards the end of March, and (2) many of the resident species started moving out of the Park in summer as the Park dried up.

The chi-square test on four categories of data sets, i.e. winter, monsoon, summer and the total study period revealed a non-random pattern and, in all cases had negative association, as the frequency of occurrence of the bronzewinged jacana without other species was greater than that with the other species (Table 2).

Spatial affinity and habitat similarity during winter, summer and monsoon:

WINTER: During winter, the highest spatial affinity recorded was for the Indian moorhen *Gallinula chloropus* followed by grey heron *Ardea cinerea* and pheasant-tailed jacana (Fig. 3).

The habitat utilization pattern of the whistling teal *Dendrocygna javanica* had the highest similarity with that of the bronzewinged jacana, followed by the yellow wagtail *Motacilla flava* (Fig. 3). Median egret *Egretta intermedia* and shoveller *Anas clypeata* showed no similarity to the bronzewinged jacana in their habitat utilization pattern.

TABLE 2

THE CHI-SQUARE ANALYSIS FOR TESTING THE HYPOTHESES THAT THE PATTERNS OF OCCURRENCE OF THE BRONZEWINGED JACANA WITH AND WITHOUT OTHER AVIAN SPECIES ARE RANDOM

Associated avian species		Status	Whole period Exp. fre = 337.5			Winter Exp. fre = 141.5			Monsoon Exp. fre = 188.5			Summer Exp. fre = 7.5		
Common Name	Scientific Name		With	Without	Chi	With	Without	Chi	With	Without	Chi	With	Without	Chi
Blackwinged Stilt	*Himantopus himantopus*	M	1	674	671	1	282	279						
Cattle Egret	*Bubulcus ibis*	R	4	671	659	10	367	338						
Comb Duck	*Sarkidiornis melanotos*	R	1	674	671	1	282	279						
Common Teal	*Anas crecca*	M	28	647	567	20	263	208	8	369	345			
Coot	*Fulica atra*	M	50	625	489	48	235	123	2	375	369			
Cotton Teal	*Nettapus coromandelianus*	R	15	660	616	15	362	319						
Gadwall	*Anas strepera*	M	6	669	651	6	277	259						
Grey Heron	*Ardea cinerea*	R	17	658	608	7	276	255	9	368	341	1	14	11
Indian Moorhen	*Gallinula chloropus*	R	85	590	377	29	254	178	55	322	189	1	14	11
Large Cormorant	*Phalacrocorax carbo*	R	1	674	671	1	376	373						
Large Egret	*Ardea alba*	R	1	674	671	1	376	373						
Lesser Whistling Teal	*Dendrocygna javanica*	R	12	663	627	4	279	267	8	369	345			
Little Egret	*Egretta garzetta*	R	2	673	667	1	376	373	1	14	11			
Little Grebe	*Podiceps ruficollis*	R	1	674	671	1	282	279						
Marsh Harrier	*Circus aeruginosus*	M	10	665	635	2	281	275	2	375	369			
Median Egret	*Egretta intermedia*	R	29	646	563	10	273	244	19	358	304			
Pheasant-tailed jacana	*Hydrophasianus chirurgus*	R	22	653	589	19	264	212	3	374	365			
Pied Myna	*Sturnus contra*	R	8	667	643	2	281	275	5	372	357	1	14	11
Pintail	*Anas acuta*	M	15	660	616	15	268	226	1	376	373			
Pond Heron	*Ardeola grayii*	R	53	622	479	20	263	208	30	347	266	3	12	5
Purple Heron	*Ardea purpurea*	R	19	656	601	4	279	267	15	362	319			
Purple Moorhen	*Porphyrio porphyrio*	R	13	662	624	8	275	251	5	372	357			
Redwattled Lapwing	*Vanellus indicus*	R	1	674	671	1	14	11						
Shoveller	*Anas clypeata*	M	22	653	589	21	262	205	1	376	373			
Darter	*Anhinga rufa*	R	3	672	663	1	282	279	2	375	369			
Spotbill	*Anas poecilorhyncha*	R	4	671	659	4	279	267						
Whitebreasted Waterhen	*Amaurornis phoenicurus*	R	9	666	639	2	281	275	7	370	349			
Wood Sandpiper	*Tringa glareola*	M	43	632	513	13	270	233	29	348	269	1	14	11
Yellow Wagtail	*Motacilla flava*	M	1	674	671	1	282	279						

$\mathrm{Chi}^2 > \mathrm{Chi}^2_{0.005}$ and hence all null hypotheses are rejected; R = Resident; M = Migrant

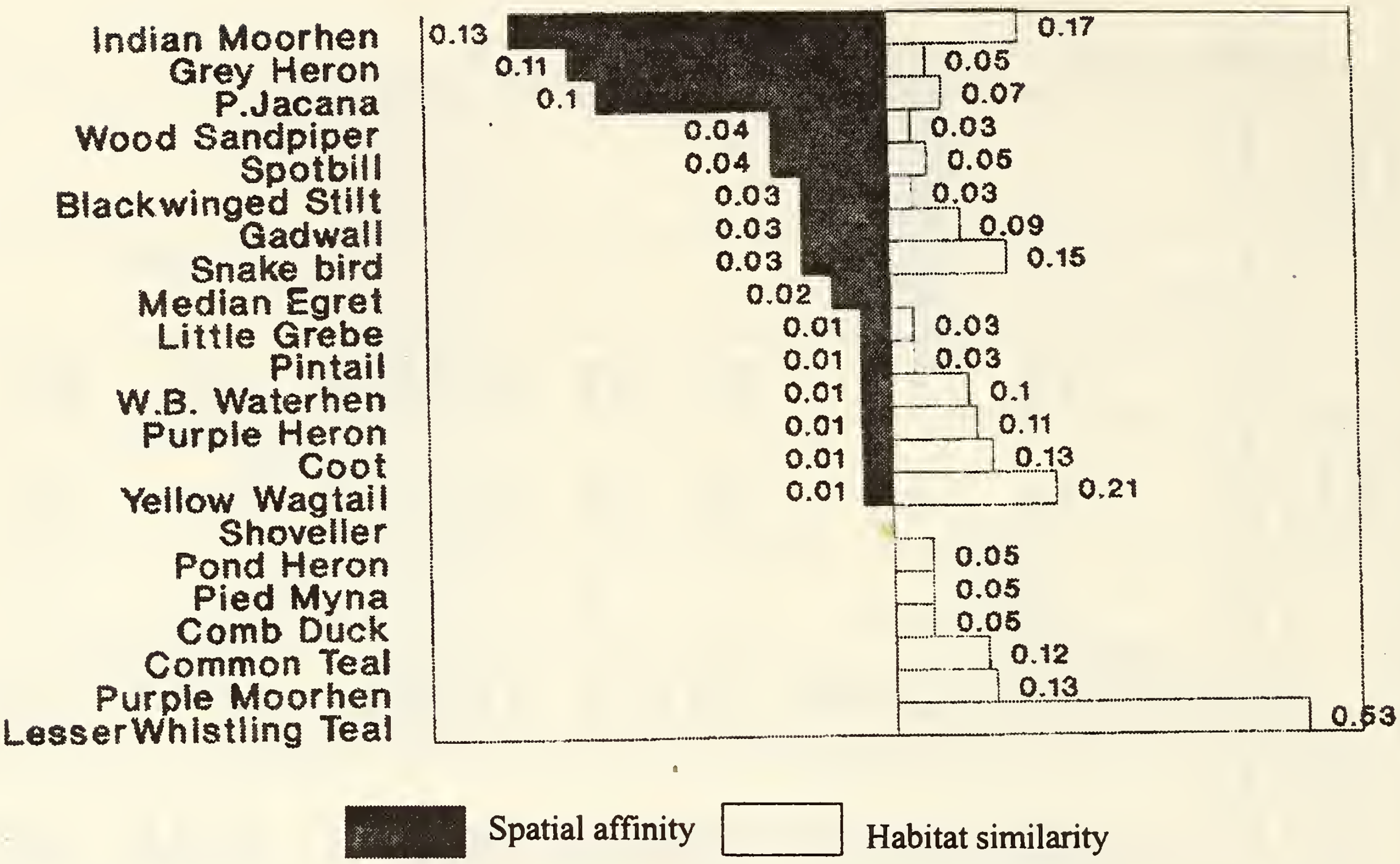

Fig. 3. Spatial affinity and habitat similarity of different avian species with bronzewinged jacana during winter

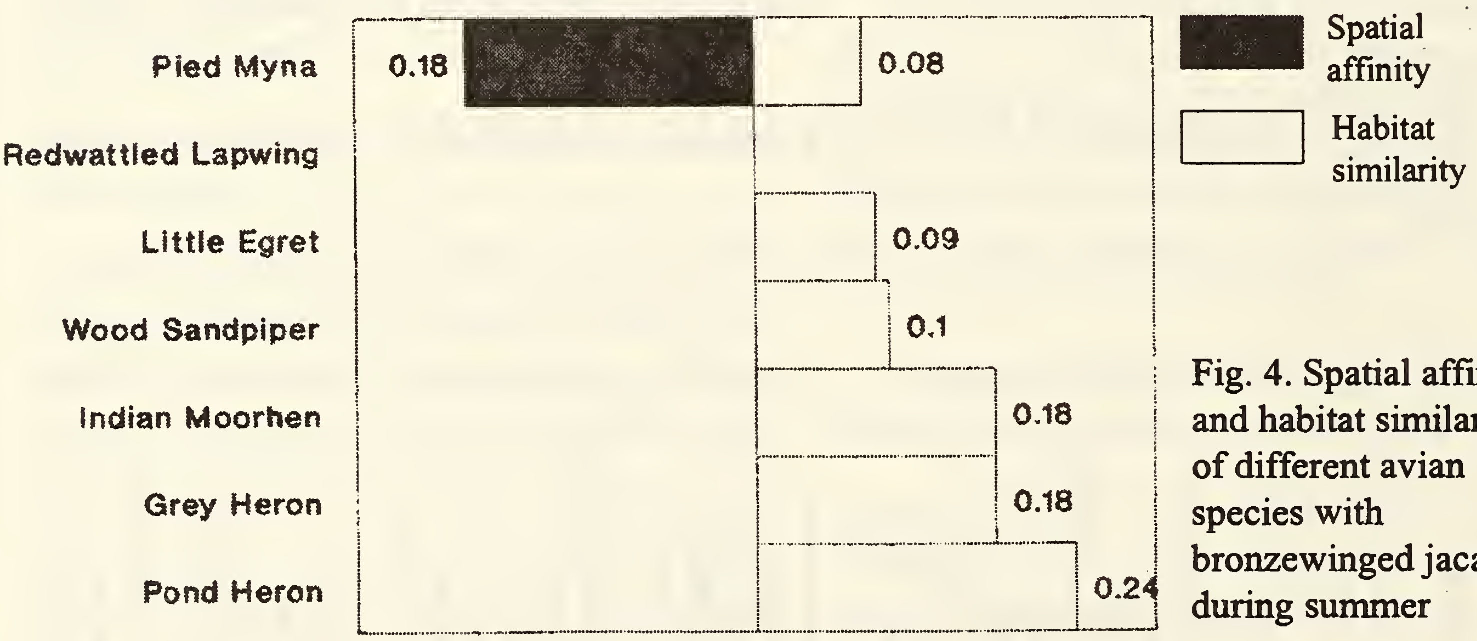

Fig. 4. Spatial affinity and habitat similarity of different avian species with bronzewinged jacana during summer

SUMMER: The pied myna *Sturnus contra* had the highest affinity towards the bronzewinged jacana during summer, as the former came in flocks to the drying marshes for foraging, and got associated with the bronzewinged jacana (Fig. 4). The rest of the associated species had no affinity towards the bronzewinged jacana. The habitat utilization pattern of the pond heron showed higher similarity with that of the bronzewinged jacana (Fig. 4).

MONSOON: The highest affinity during monsoon was shown by the little egret *Egretta garzetta*, followed by wood sandpiper *Tringa*

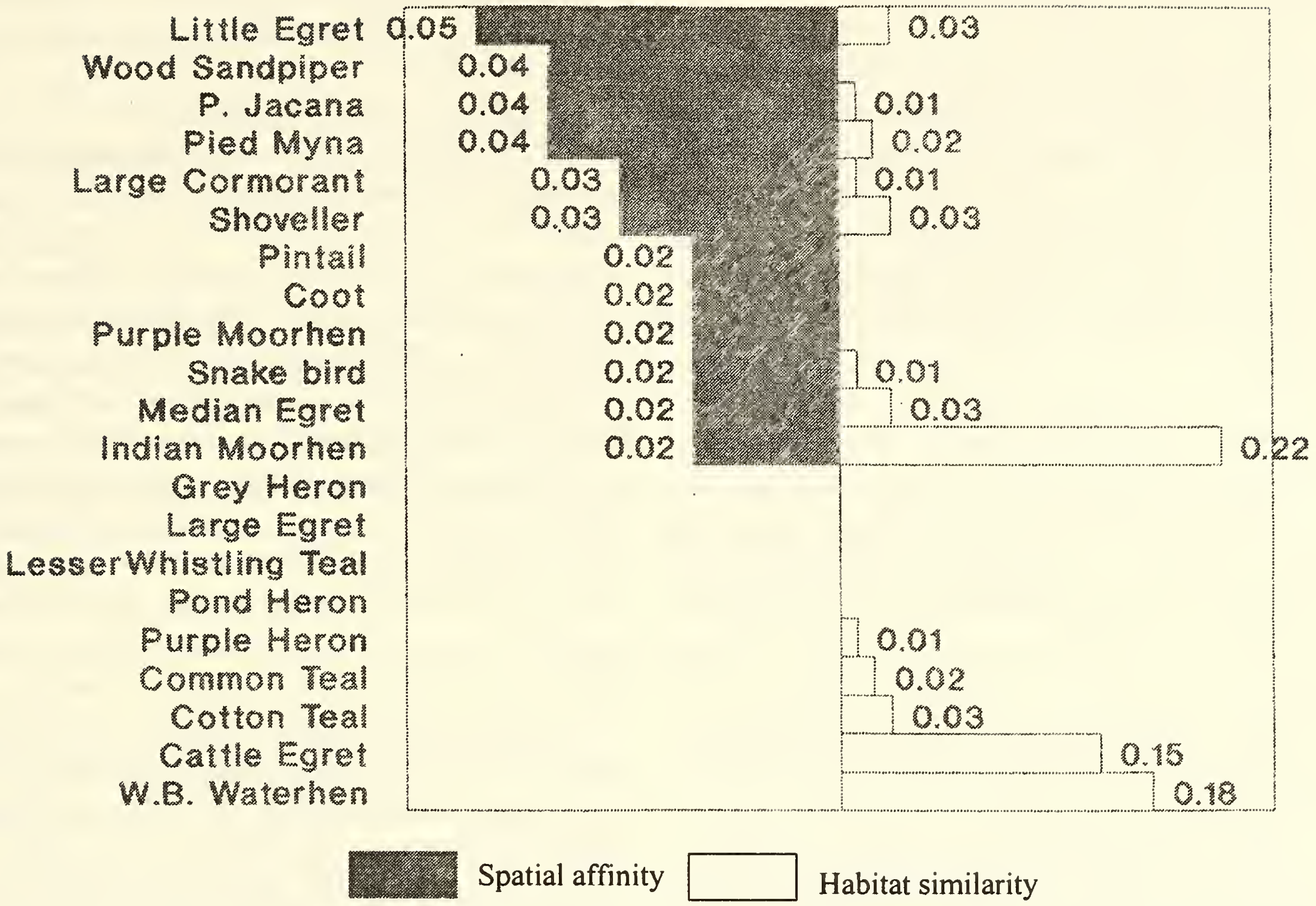

Fig. 5. Spatial affinity and habitat similarity of different avian species with bronzewinged jacana during monsoon

glareola, pheasant-tailed jacana and pied myna (Fig. 5). The Indian moorhen showed the highest similarity in habitat use pattern to the bronzewinged jacana (Fig. 5).

The values of spatial similarity and habitat similarity were insignificant in all the seasons. However, the pattern obtained is worth mentioning; the values of spatial affinities in different seasons reveal that none of the species had shown consistent affinity throughout the season. This is more clear during winter and monsoon. If the species were consistently showing more or less the same affinities towards bronzewinged jacana during both the seasons, they could be interpreted as associated. But the case was reverse, which further corroborates the result obtained from the association analysis.

Agnostic interaction of the Bronzewinged Jacana:

Agnostic interspecific interactions in the bronzewinged jacana were noted only in the breeding season, which is associated with the protection of young ones. On one occasion they were found chasing away the Indian moorhen. Mathew (1964) reports that they chase away waterhen *Amaurornis phoenicurus* and pond heron. Chattopadhyay (1981) narrated an incident in which the bronzewinged jacana aggressively defended an injured chick from intruders, namely cotton teal *Nettapus coromandelinus,* lesser whistling teal, pheasant-tailed jacana, whitebreasted kingfisher *Halcyon smyrnensis* and little grebe. In the present study, no such interactions were observed against these species, probably because they are not actual predators. Only the marsh harrier, which is an important predator of this bird was found eliciting an aggressive response from this bird and on one occasion a harrier was physically assaulted by the bronzewinged in defence of its chick. This type of antipredator behaviour was reported in Northern jacana *spinosa* against the American purple gallinule *Gallinula martinica* which is a predator of its eggs (Stephens 1984a, 1984b).

Discussion

Pielou (1972) discussed three ways by which negative association is effected: (1) differences in habitat preferences, (2) behavioural exclusion or repulsion and (3) effect of past population histories. In jacanas, difference in habitat preference resulted in negative association in some cases, whereas in certain cases this is through spatial segregation.

A comparison of the values of spatial affinity with those of habitat similarity of the associated species revealed that in general the species with higher affinity values had lower habitat similarity with the pheasant-tailed jacana (Fig. 2). The bronzewinged also reflect almost the same trend in all three seasons (Figs. 3, 4 & 5). This indicated that resources (vegetation patches) are abundant for those species having higher overlap with the jacanas and therefore, they spatially distribute each other in such a way resulting in negative association. Nevertheless, the pattern obtained for the bronzewinged jacana during winter did not clearly show this relationship (Fig. 5), for there are birds showing medium tendencies in their relationship between spatial affinity and habitat similarity. This may either be due to the high density of the associated species or the limited patch availability.

The marsh harrier seems to be the only important predator of bronzewinged jacana. This bird invited aggressive physical assault from the bronzewinged and this type of direct antagonistic reaction is reported in Northern jacana also against the purple gallinule (Stephens 1984a, 1984b).

Flocking is an anti-predatory tactic in many bird species (Page and Whitacre 1975, Kenward 1978, Bertram 1980). Here, the Flock is defined as a semipermanent cohesive group of individuals of the same species, showing synchronized behaviour. The pheasant-tailed jacana forms only single species flocks. Birds in flocks may be safer than solitary individuals for at least three reasons (i) individuals in a group may detect predators better or earlier than smaller groups or solitary individuals (Pulliam 1973; Siegfried and Underhill 1975, Kenward 1978; Lazarus 1979), (ii) a predator which attacks a group of prey may become confused and catch fewer prey (Neill and Cullen 1974, Milinsky 1979; Randaue and Terborgh 1986), and (iii) an individual in a group may reduce its chance of being caught simply because of a dilution-effect (Foster and Treherne 1981, Powell 1974). Carco *et al.* 1980 predicted that small birds which live in flocks (<20) respond to increased risk of predation by increasing group size. The flock size of pheasant-tailed jacana ranged from 8 to 13 throughout the study period and no increase in the group size was noticed. Thirteen was the maximum population size during the winter of 1986. McWilliams *et al.* (1984) also did not observe flock size increase in cackling geese and Ross' geese (*Branta canadensis minima* and *Chen rossii*) in relation to increased predation risk. They suspect that the flock size of these species is primarily dictated by the distribution and abundance of food plants and the local population size of geese. It may be true in the case of pheasant-tailed jacana also, where the local population size would have decided the flock size.

Conclusion

The pattern of occurrence of the pheasant-tailed and bronzewinged jacanas with all other avian species was non-random and the nature of association was characterized as negative, as the frequency of occurrence with other avian species was less than without them. The bronzewinged jacana, when treated season-wise, also showed non-random pattern and negative association.

Those species which showed higher similarity in their habitat preference to that of the bronzewinged jacana showed lesser affinity towards it. None of the species showed consistent affinity with bronzewinged jacana in any season, especially during monsoon and winter, which proves that they are negatively associated with it.

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NEW DESCRIPTIONS

GLYPTOTHORAX DAVISSINGHI (PISCES: SISORIDAE) A NEW CAT FISH FROM NILAMBUR IN THE NILGIRI BIOSPHERE RESERVE, SOUTH INDIA[1]

A. Manimekalan[2,3] & H.S.Das[2]

(*With three text-figures*)

A new species of *Glyptothorax* is described from Karim Puzha, Nilambur, Western Ghats. The specimen is different from all other known *Glyptothorax* species, characterised by dorsal fin serrated posteriorly, plaited paired fins, adhesive apparatus with distinct central pit and occipital process not reaching the basal bone of the dorsal fin.

Introduction

During the course of our survey of fishes in the Nilgiri Biosphere Reserve (NBR), a specimen of a new *Glyptothorax,* Sisoridae was collected from the Karim Puzha and its tributary Panna Puzha, Maancheri, Nilambur forest (Kerala), a part of the Nilgiri Bisphere Reserve (NBR) of Western Ghats.

Karim Puzha is one of the westward flowing river systems in the Chaliyar river basin. It originates from the Kundah hills and drains through the steep western slopes of the Nilgiri hills (Nilambur, Maancheri, Edakode and New Amarambalam) with a series of rapids, cascades and falls. Karim Puzha is one of the main water source among the other three rivers (Chaliyar Puzha, Punna Puzha and Pallisseri Puzha) in Chaliyar river basin. It flows through the dense moist evergreen forest areas of Nilambur Reserve Forest.

Five specimens of *Glyptothorax* have been collected from river Karim Puzha during the survey. Occurrence of *Tor khudree,* a rare and threatened fish species of Karim Puzha here, is remarkable. Karim Puzha is a good breeding habitat for *Tor khudree.* The present species differs from all other *Glyptothorax* species described so far: Menon (1954), Jayaram (1981), Day (1994) and Talwar and Jhingran (1991).

Glyptothorax davissinghi sp. nov.

(Fig. 1)

Material and Methods

Material examined: 5 specimens 68.0-121.0 mm standard length (SL), from Karim Puzha and its tributary Panna Puzha, Maancheri, Nilambur forest, Kerala. The first specimen was collected when tribals (Cholanayakan) were demonstrating a traditional fishing technique by using plant material (bark of *Acacia intsia*) as fish poison. Later, some individuals were collected by dip netting under and around rocks. Specimens were measured using dial calipers with a least count of 0.02 mm, following standard practices. Description of the new species is based on the pooled average of all the samples (Table 1). Data is presented as standard length (SL) and head length (HL), with the mean followed by the range in parenthesis.

Diagnosis: Head and snout greatly depressed and broad. Eyes small, superior, subcutaneous. 8 barbels—2 nasal barbels, 2 maxillary barbels and four mandibular barbels. Maxillary longer with broad base reaching beyond base of pectoral fin. Mandibular barbels do not reach gill opening. Adhesive apparatus

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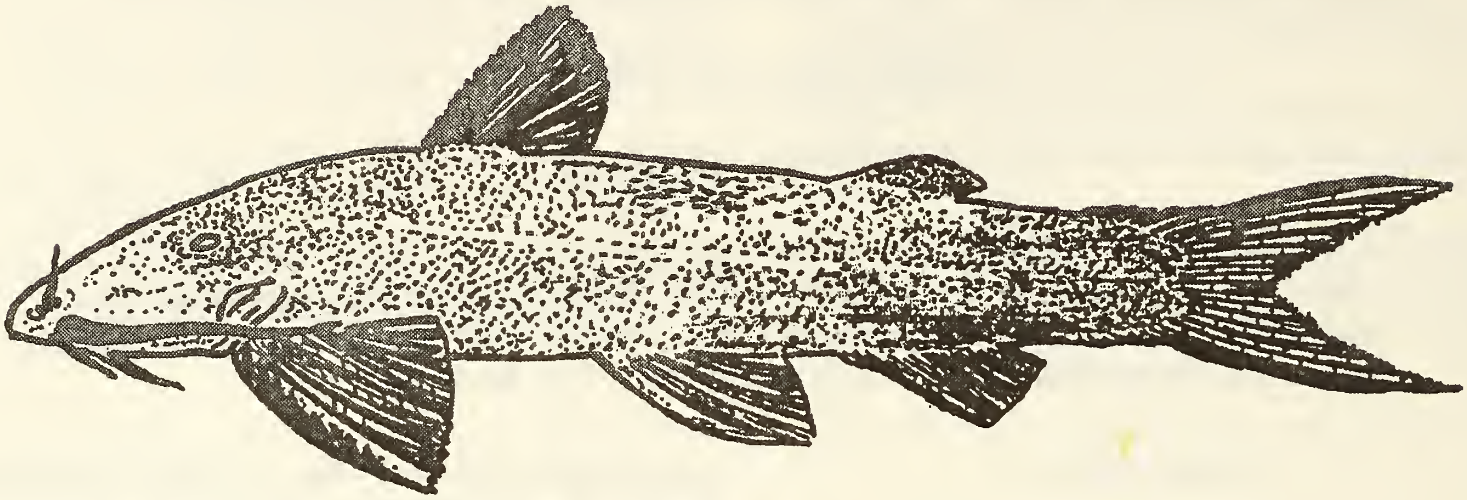

Fig. 1. Lateral view of *Glyptothorax davissinghi* sp. nov., 121.0 mm SL.

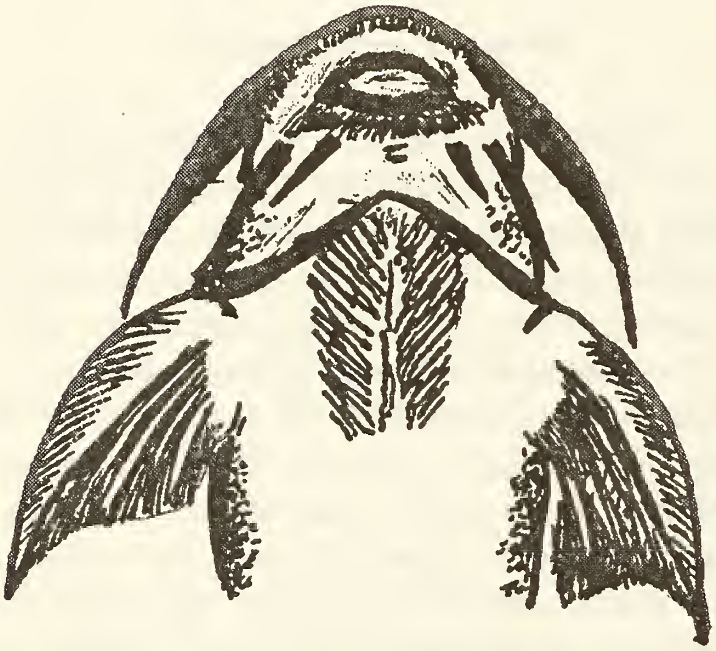

Fig. 2. Plaited paired fins and adhesive apparatus with distinct central pit.

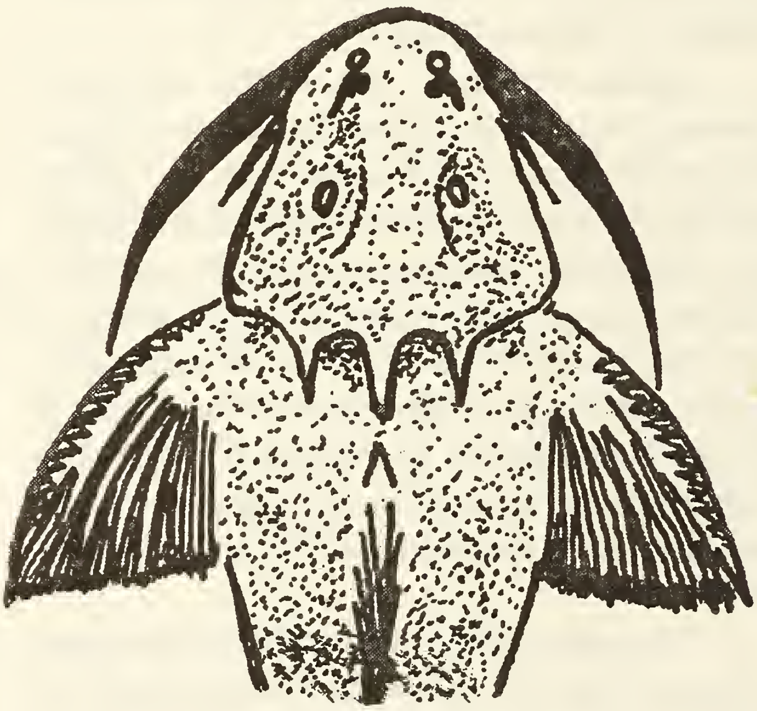

Fig. 3. Occipital process not reaching the basal bone of the dorsal fin.

well developed with distinct central pit (Fig 2). Dorsal fin serrated posteriorly. All fins with white edges. Plaited paired fins with serration. Origin of dorsal fin closer to snout than to caudal. Occipital process not reaching dorsal fin base (Fig. 3). Body with rough granular skin, dark grey without bands. Lips not fringed. Ventral side of the body golden in colour in living condition and white on preservation, up to ventral fin. Caudal fin deeply forked.

Table 1

MORPHOMETRIC DATA OF *GLYPTOTHORAX DAVISSINGHI* SP. NOV. (5 SPECIMENS)

Measurement details	SL		HL	
	$\overline{X}$	range	$\overline{X}$	range
Standard length 99.2 mm (68.0-121.0)				
Head length (HL)	4.48	4.32-4.51		
Body depth	6.22	5.76-6.48		
Predorsal distance	3.03	2.76-3.16		
Postdorsal distance	1.26	1.21-1.32		
Height of dorsal fin	6.12	5.88-6.72	1.37	1.29-1.56
Length of dorsal fin	4.77	4.53-5.04	1.25	1.14-1.33
Length of pectoral fin	4.52	4.23-4.95	1.23	1.04-1.47
Length of pelvic fin	5.27	5.22-5.38		
Length of anal fin	5.51	5.24-5.72		
Caudal fin length	4.88	4.70-5.15		
Distance from pectoral and pelvic base	3.70	3.62-3.81		
Distance from pelvic to anal origin	4.55	4.38-4.84		
Length of body cavity	2.08	2.00-2.15		
Depth of head			2.13	2.00-2.33
Maximum head width			1.21	1.17-1.24
Eye diameter			10.01	9.33-10.67
Snout length			1.76	1.69-1.87
Interorbital width			3.15	3.00-3.50
Length of caudal peduncle/Depth of caudal peduncle	1.99	1.92-2.10		
Height of dorsal/Base of dorsal	1.51	1.38-1.68		
Height of anal fin/ Base of anal	0.93	0.92-0.94		
Predorsal distance/ Postdorsal distance	0.41	0.42-0.46		

Description: (Table 1) D. 1/6; P. 1/9-10; V. 1/8, a. 2/5; C. 6/16-18. Dorsal side of the body convex, ventral side almost flat. Length of head 5.39 (5.14-5.59) in total length (TL), 4.48 (4.32-4.51) in standard length, its depth 2.13 (2.00-2.33) and width 1.21 (1.17-1.24) in head length; body depth 6.52 (6.00-6.87) in total length; 6.22 (5.76-6.48) in standard length; predorsal distance 3.03 (2.76-3.16), postdorsal distance 1.26 (1.21-1.32), distance from pectoral base to pelvic base (3.70 (3.62-3.81), distance from pelvic to anal 4.55 (4.38-4.84), length of body cavity 2.08 (2.00-02.15) in SL; dorsal situated closer to snout than to caudal base; last unbranched ray strong, posteriorly serrated; postdorsal distance 0.41 (0.42-0.46) in predorsal distance; height of dorsal fin 6.12 (5.88-6.72) SL and 1.37 (1.29-1.56) in head length; base of dorsal fin 1.51 (1.38-1.55) in dorsal fin height; length of pectoral fin 4.52 (4.23-4.95) in SL and 1.23 (1.04-1.47) in HL; pelvic fin 5.27 (5.22-5.38) in SL; anal fin length 5.51 (5.24-5.72) in SL; caudal fin 4.88 (4.70-5.15) in SL; depth of caudal peduncle 1.99 (1.92-2.10) in its length. Eye diameter 10.01 (9.33-10.67), snout length 1.76 (1.69-1.87) and interorbital width 3.15 (3.00-3.50) in head length. Four pairs of barbels, one pair each of maxillary, nasal and two of mandibular; maxillary pair with broad base.

Holotype: Sálim Ali Centre for Ornithology and Natural History (SACON), Coimbatore; Register No. SACON/SSGs 11; 112 mm SL; Karim Puzha and its tributary Panna Puzha 7 km upstream from Cholanayakan colony at Maancheri, Nilambur Reserve Forest, Kerala, India; altitude 160-190 m; moist evergreen forest; 16th March and 7th April 1995; Coll.: Late D.F. Singh, Mathew K. Sebastian and A. Manimekalan.

Paratypes: 5 specimens, with same details as above, range 68-121 mm SL, data as above. Type specimens deposited in SACON; one specimen will be sent to the national collection of the Zoological Survey of India (ZSI), Chennai.

Relationship: This new species has been compared with related species (Table 2) such as *Glyptothorax annandalei* Hora and *Glyptothorax madraspatanum* (Day). Features such as the dorsal fin serrated posteriorly, plaited paired fins, adhesive apparatus with central pit and occipital process not reaching the basal of the dorsal fin easily distinguish *Glyptothorax davissinghi* sp. nov. from the above mentioned species. Both the species were described from Bhavani river at the base of Nilgiri hills, *Glyptothorax madraspatanum* from Bhavani and Moyar rivers and their tributaries (Rajan, 1956). *Glyptothorax annandalei* Hora was reported from Silent Valley,

TABLE 2
COMPARISON OF CHARACTERS IN THE RELATED SPECIES

Characters	*G. davissinghi* sp. nov.	G. *annandalei* Hora	*G. madraspatanum* (Day)
Dorsal fin	Strong, serrated posteriorly	With a weak entire spine, without serration	With a weak entire spine, with serration
Pectoral fin	Plaited	Plaited ventrally	Non-plaited
Adhesive apparatus	Well developed, longer than broad, with a distinct central pit, reddish.	Longer than broad without a central pit, yellowish	Longer than broad, without a central pit, yellowish
Occipital process	Not reaching basal bone of dorsal fin	Reaching basal bone of dorsal fin	Reaching basal bone of dorsal fin
Body	Rough with granules dark grey without longitudinal bands	Granulated, dark grey, with 2 longitudinal bands	Smooth, yellowish with dark bands
Maxillary barbels	Reaching beyond base of pectoral fin	Reaching 3rd or 4th pectoral ray.	Reaching pectoral base

Kerala (Rema Devi and Indra, 1986). During the present survey, these two species were also collected from same rivers.

Etymology: The nominal name is given in memory of the late Dr. Davis Franc Singh (D.F. Singh), Senior Scientist, Sálim Ali Centre for Ornithology and Natural History (SACON), who was involved in survey, conservation of fish and fish habitat of Western Ghats for more than a decade and was the brain behind this survey.

Coloration: In live specimens the body is dark grey and the ventral side of the body is of a golden colour; in formalin white in colour up to ventral fin. Adhesive apparatus reddish. All fins have white edges.

Maximum size: 121 mm SL.

Range: Karim Puzha, Kerala, Western Ghats.

Status: Endemic to Karim Puzha, Kerala, Western Ghats.

KEY TO SOUTH INDIAN SPECIES OF GLYPTOTHORAX

1a. Adhesive thoracic apparatus well developed .. 2
1b. Adhesive apparatus feebly developed, as long as broad .... *G. anamalaiensis*
2a. Adhesive apparatus longer than broad 3
2b. Adhesive apparatus broader than long without central pit .... *G. housei*
3a. Adhesive apparatus without central pit 4
3b. Adhesive apparatus with central pit 5
4a. Occipital process reaching basal bone of dorsal, pectoral fin non-plaited ...... *G. madraspatanum*
4b. Occipital process apposed to basal bone of dorsal fin .... *G. lonah*
5a. Dorsal fin spine weak, smooth .. *G. annandalei*
5b. Dorsal fin spine strong, serrated posteriorly, pectoral fin plaited ventrally ...... *G. davissinghi*

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A NEW SPECIES OF *BIOSTERES* FOERSTER FROM INDIA (INSECTA: HYMENOPTERA: BRACONIDAE)[1]

S.M. Kurhade[2] & P.K. Nikam[3]

(*With three text-figures*)

Introduction

The genus *Biosteres* Foerster belongs to the subtribe Biosterina of the tribe Opiini of the subfamily Opiinae. Foerster (1862) erected *Biosteres* with *Bracon carbonarius* Nees, which was originally designated as the type species.

Fischer (1965) revised the genus *Biosteres* totally and later Fischer (1967, 1971, 1973) also attempted taxonomy of the genus. Fischer (1978) divided *Biosteres* into two subgenera *viz.*, *Chilotrichia* Foerster and *Biosteres* Foerster s. str. and also provided a key to Indo-Australian species of *Biosteres* Foerster s. str.

Only three species of the subgenus *Biosteres* Foerster s. str. *viz., Biosteres (Biosteres) testaceipes* Cameron (1911), *Biosteres (Biosteres) kashmirensis* Fischer (1966) and *Biosteres (Biosteres) towensi* Papp (1983) have been recorded so far from India.

In this work, a new species belonging to the subgenus *Biosteres viz., Biosteres (Biosteres) sahyadrensis* is described on the basis of material collected in India, Maharashtra, Aurangabad. Thus there are five taxa under *Biosteres (Biosteres)* from the Indo-Australian region of which four are from India.

A key to the Indo-Australian species of *Biosteres (Biosteres)* by Fischer (1978) which was in German has been translated in to English and the new species, *Biosteres (Biosteres) sahyadrensis* is also included.

Types of this species are in the collection of the second author and will be deposited in the National Collection of the Zoological Survey of India, Calcutta, India.

A key to the species of subgenus *Biosteres* Foerster s. str. by Fischer (1978)

1. Mesonotum complete, moderately, uniformly punctate; antennal segment 4 longer than 3; 4.4 mm, India, H.P.; Simla..... *testaceipes* Cameron (1911)
— Mesonotum smooth and bare, almost stout, notauli with small punctures throughout; antennal segment 4 almost as long as 3 2
2. Almost complete abdomen and all legs reddish-brown; head and thorax black; 4.1 mm, India. J.K., Kashmir... *kashmirensis* Fischer (1966)
— Head and thorax not black; whole body yellowish-red 3
3. Body yellowish-red; ovipositor sheath black; 4th, 5th and 6th tergites reddish-brown on middorsal side; 5.00 mm, India, Maharashtra, Aurangabad .... *sahyadrensis*. sp. nov.
— Head, thorax and abdomen reddish-brown..... 4
4. Almost complete abdomen and all legs completely black; head and thorax red; 4.1 mm, Australia, Victoria.. .... *tenebrigaster* Fischer (1978)
— Head and abdomen dark brown; all legs brownish-yellow; thorax brownish-yellow; 3.2 mm, India, West Bengal................................. .... *townesi* Papp (1983).

Biosteres (Biosteres) sahyadrensis, sp. nov.
(Figs. 1-3)

Female: 5.00 mm (Fig. 1). Head (Fig. 2) 0.3 times as long as wide, head in dorsal view,

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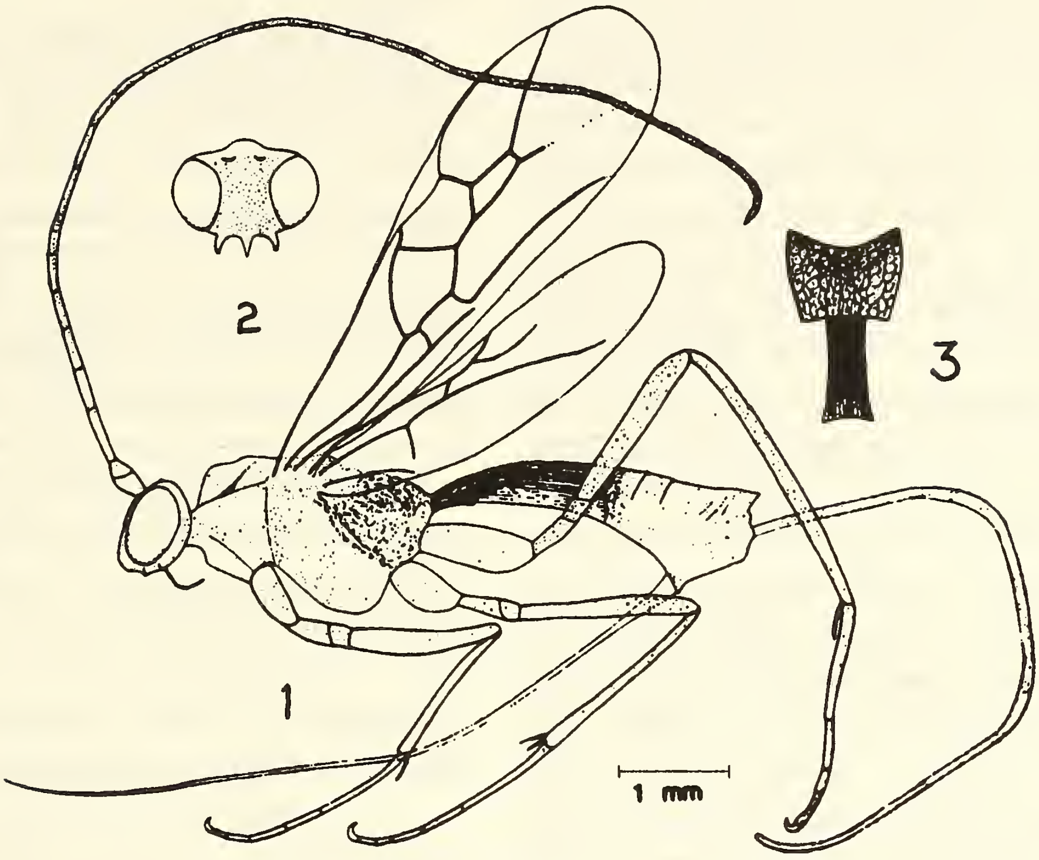

Fig. 1-3: *Biosteres* (*Biosteres*) *sahyadrensis*, sp. nov. (Female). 1. Adult, lateral view; 2. Head, frontal view; 3. Propodeum with first abdominal tergite.

behind eyes not broadening; vertex shiny, smooth; ocelli in triangle on black oblong spot; interorbital distance 5x ocello-ocular distance; interocellar distance as long as ocello-ocular distance; frons smooth, shiny, slightly concave; antenna long, 2 + 46 segmented; scape 2x as long as wide, smooth, very weakly punctate, pubescent; pedicel 1.2x as long as wide, smooth, pubescent; 1st flagellar segment 6.3x as long as wide, moderately punctate, pubescent; flagellum with fine bristles throughout the length; penultimate segment 1.5x as long as wide; terminal segment 5x as long as wide; face 0.7 times as long as wide, smooth, weakly punctate, pubescent; clypeus as long as wide, with a long tooth-like outgrowth at anterior side, convex, smooth, weakly punctate, pubescent; malar space 0.5 times the basal width of mandible, smooth; mandible 2.5x as long as wide, bare; occipital carina absent; temple smooth, shiny, weakly punctate, in lateral view 1.25x as long as eye.

THORAX: 2.3x as long as wide; pronotum shiny, moderately, shallowly punctate, pubescent; mesoscutum smooth, shiny, convex, very weakly, shallowly punctate, pubescent; median lobe without any groove or carina; notauli distinct, transversely crenulated; disc of scutellum convex, closely punctate, pubescent, apex smooth; propleurum smooth, weakly punctate, pubescent; mesopleurum smooth, moderately, closely punctate, pubescent; mesopleural suture distinct; sternaulus not distinct; metapleurum rugosely, moderately punctate, pubescent; post-scutellum depressed; propodeum (Fig. 3) rugoso-reticulate, very weakly, shallowly punctate at the basal area, pubescent; propodeal spiracle round. Hindleg coxa 2.5x as long as wide, smooth, moderately, weakly punctate, pubescent; trochanter 0.7 times as long as coxa, moderately punctate, pubescent; femur 8.5x as long as wide, moderately punctate, pubescent; tibia 1.6x as long as femur; tibial spur 0.4 times as long as basitarsus; claw bifid. Forewing 3.5x as long as broad; stigma 5x as long as wide; radius ending before tip of wing; first abscissa of radius 1.4x as long as width of stigma; second abscissa of radius 1.8x as long as first abscissa; third abscissa of radius 4.5x as long as first abscissa; first intercubitus 22.2x as long as second intercubitus; metacarpus 1.4 x as long as stigma; cubitus not sclerotized throughout; basal 0.55 times as long as medius, costa 1.55x as long as medius; nervulus slightly inclivous, as long as width of stigma; subdiscoidius as long as submedius; margin with fine bristles; hind wing 4.6x as long as broad; subcostella 1.85x as long as mediella; mediella 6.3x as long as basella; nervellus inclivous, 0.4 times as long as submediella; margin with fine bristles.

ABDOMEN: 5x as long as wide; first tergite 1.9x as long as apical width, strigose, pubescent; second tergite 1.2x as long as wide, striate, pubescent; third tergite as long as wide, basal half striate, apical half smooth, weakly punctate, pubescent; remaining tergites smooth, shiny, weakly punctate, pubescent; ovipositor 1.2x as long as ovipositor sheath, the latter with stiff bristles throughout the length.

Yellowish-red. One oblong spot on vertex, veins, stigma, ovipositor sheath black; 4th, 5th and 6th tergites reddish-brown on middorsal side.

MALE: Unknown.

Holotype: Female: INDIA: Maharashtra: Aurangabad, 25.xi.1987, on wing, coll. P.K. Nikam; Antenna, wings and legs mounted on slides and labelled as above.

Paratypes: 12 females, data same as holotype.

Comments: According to the key to the Indo-Australian species of the subgenus *Biosteres* Foerster s. str. by Fischer (1978) *Biosteres (Biosteres) sahyadrensis,* sp. nov. approaches *Biosteres (Biosteres) kashmirensis* Fischer (1966) in the following characters: (1) propodeum rugoso-reticulate, (ii) sternaulus not distinct and (iii) mesonotum smooth, bare. However, the new taxa differs from the same in having the following pecularities: (i) sternaulus not distinct and (iii) mesonotum smooth, bare. However, the new taxon differs from the same in the following pecularities: (i) head in dorsal view behind eyes not broadening, (ii) temple in lateral view 1.25x as long as eye, (iii) antenna 2 + 46 segmented, (iv) radius ending before tip of wing and (v) head, thorax and abdomen yellowish-red.

In addition *Biosteres (Biosteres) sahyadrensis,* sp. nov. shows superficial resemblance with *Biosteres (Biosteres) townesi* Papp (1983), but differs from the same in having the following additional characters (i) propodeum rugoso-reticulate, (ii) body 5 mm in length, (iii) notauli distinct, (iv) first abscissa of radius 1.4 X as long as width of stigma and (v) nervulus slightly inclivous.

ACKNOWLEDGEMENTS

We thank the former Head, Department of Zoology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad for providing laboratory facilities. The first author wishes to thank the Principal, New Arts, Commerce and Science College, Ahmednagar for permission to work at Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.

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STUDIES ON INDIAN SPECIES OF *CARDIORHINUS* ESCHSCHOLTZ (COLEOPTERA, ELATERIDAE: CARDIORHININAE)[1]

PUNAM GARG AND V. VASU[2]

(*With eleven text figures*)

Key words: New species, *Cardiorhinus* Esch., Elateridae, India.

To the previously recorded single species of genus *Cardiorhinus* Eschscholtz, *C. emarginatus* sp. nov. is added afresh, which is described and illustrated in detail. A combination of significant characters which distinguish it from the previously recorded species are given under diagnostic characters.

INTRODUCTION

Established by Candeze (1863), the subtribe Cardiorhinites, based on genus *Cardiorhinus* Eschscholtz which was raised to subfamily Cardiorhininae by Schenkling (1927) remained unreported from the Indian region till Vats and Chauhan (1993) described one new species *C. truncatus* from this subcontinent. The type species is *C. seminiger* Eschscholtz (1829).

The present text includes two species collected by the authors, of which one new species is described and illustrated, while brief diagnostic characters and illustrations are provided for the known species viz. *C. truncatus* Vats and Chauhan.

Type material of the new species will be deposited at the Division of Entomology, Pusa National Collections, Indian Agricultural Research Institute, New Delhi.

DIAGNOSTIC FEATURES OF THE GENUS: Body pubescent, elongate. Head flat; labrum indented, bilobed; antenna extending beyond posterior angle of prothorax, segment 2 smallest, last segment constricted near apex. Prothorax with posterior margin entire; prosternal spine rounded. Metacoxal plate dilated in the middle. Aedeagus longer than parameres. Parameres simple, with subapical processes.

KEY TO INDIAN SPECIES OF GENUS *Cardiorhinus*

1. Prosternal spine marginate, gradually narrowing at base (Fig. 2); scutellum (Fig. 3) subquadrate, without medial depression, lateral sides straight; elytra emarginate at extremities (Fig. 6) less than 3x prothorax length, striae indistinct .... *emarginatus* sp. nov.
2. Prosternal spine not marginate, abruptly narrowing at base (Fig. 1); scutellum (Fig. 10) subpentagonal with medial depression, lateral sides concave; elytra (Fig. 8) truncate at extremities, more than 3x prothorax length, striae distinct .... *truncatus* Vats & Chauhan

Cardiorhinus emarginatus sp. nov.
(Figs. 1-6)

Description: Colour: Body black, legs and antennae fuscous.

Measurements: Body length 3.5 mm; head length 2 mm, width 1.75 mm; antenna 7.75 mm, 2nd segment 0.3 mm, 3rd segment 0.4 mm, 4th segment 0.8 mm, last segment 0.8 mm; thorax length 6 mm, width 3.5 mm; elytra 15.5 mm.

Structure: Body width less than 0.25x its length. Head flat, inclined, longer than broad; frons with anterior margin arcuate; antenna reaching posterior angles of pronotum, segment 3 longer than segment 2 as 4:3 but distinctly

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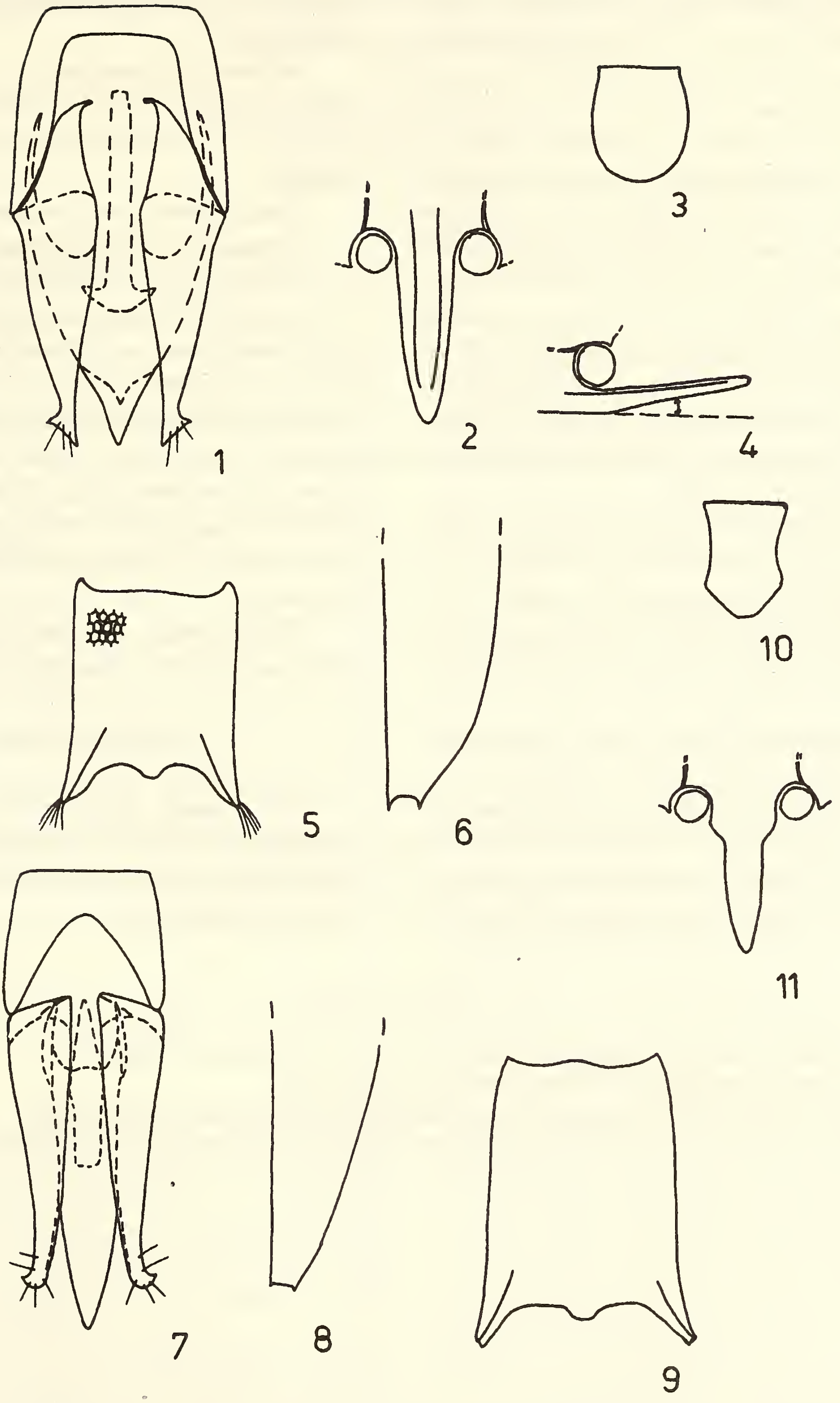

Figs. 1-6. *Cardiorhinus emarginatus* sp. nov.: 1. Male genitalia, 2. Prosternal spine (Ventral view), 3. Scutellum, 4. Prosternal spine (Lateral view), 5. Pronotum, 6. Elytra (Posterior part); Figs. 7-11. *C. truncatus* Vats & Chauhan: 7. Male genitalia, 8. Elytra (Posterior part), 9. Pronotum, 10. Scutellum, 11. Prosternal spine (Ventral view).

shorter than segment 4 as 1:2. Pronotum convex, longer than broad as 12:7; lateral sides parallel, posterior margin entire; posterior angles obliquely truncate with a tuft of setae (Fig. 5), carinate, carina short, not reaching middle of pronotum; prosternal spine rounded, margined, gradually narrowing from base (Fig. 2), declined from its main axis at 10° (Fig. 4). Metasternum truncate between mesocoxae. Scutellum flat, longer than broad as 4:3, anterior margin truncate, posterior margin arcuate (Fig. 3). Elytra convex, 2.6x prothorax length, emarginate at extremities with pointed angles (Fig. 6); striae indistinct. Metabasitarsus shorter than following 2 joints combined as 4:5.

Sculpture: Head with simple, dense, small, hexagonal punctation; pronotum (Fig. 5) and propleurae punctate like head; prosternum with simple, sparse, rounded punctation; elytra with simple, dense, rounded punctation.

Pubescence: Body covered with simple, dense, slanting, yellowish brown pubescence.

Male genitalia: (Fig. 1). Phallobase with straight anterior margin. Parameres simple, with subapical processes. Aedeagus almost equal to parameres, broad, tapering posteriorly into pointed tip; furcae not reaching anterior margins of parameres.

Material examined: *Holytype*: Male, Assam, Jatinga, 750 m, 15.v.1994, Coll. Punam. *Paratypes*: 2 Females with same data as holotype.

Distribution: INDIA: Assam.

Diagnostic combinations: On the basis of the following significant characters, *C. emarginatus* is separated from *C. truncatus*: elytra emarginate at extremities (truncate in *truncatus*); posterior angle with a tuft of setae (without setae in *truncatus*); prosternal spine gradually narrowing from base (abruptly narrowing in *truncatus*); elytra less than 3x prothorax length (more than 3x in *truncatus*), and scutellum subquadrate (subpentagonal in *truncatus*).

Etymology: Species name alludes to emarginate posterior margin of elytra.

ACKNOWLEDGEMENT

We thank Prof. (Dr.) L.K. Vats, Kurukshetra University, Kurukshetra, India for allowing physical verification of beetles and for valuable suggestions.

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A NEW SPECIES OF *CLERODENDRUM* (VERBENACEAE) FROM NORTHEASTERN INDIA[1]

A. Rajendran[2] & P. Daniel[3]

(*With a text-figure*)

A new species, *Clerodendrum panigrahianum*, from Arunachal Pradesh in northeastern India, is described with an illustration.

Specimens of the genus *Clerodendrum* in Indian herbaria were studied for a revision of the Indian Verbenaceae. It was found that some specimens collected in Arunachal Pradesh in northeastern India and housed at ASSAM and CAL had been wrongly identified as *Clerodendrum bracteatum* Wall. ex Walp. (1845) which is typified by Wallich, *Numer. List No.* 1800, collected in Pundua, now in Bangladesh. Clarke (1885) recorded it for British India from Sikkim, Bhutan, Mishmee, Assam, Cachar and the Khasia mountains. Though the specimens from Arunachal Pradesh referred to above apparently resembled *C. bracteatum,* a critical study showed that they belonged to an undescribed species which is described here with an illustration. A comparison is made with the closely related *C. bracteatum.*

Clerodendrum panigrahianum sp. nov.
(Fig. 1).

C. bracteatum Wall. ex Walp. affinis sed foliis serratis; inflorescentiis terminalibus, solitariis, capitatis; pedunculis 1 - 4 cm longis; floribus multis, condensatis; bracteis lineario-ellipticis vel oblongis; calycibus sub-campanulatis, laviter divisis et tubis corollae brevioribus differt.

Typus: INDIA: Arunachal Pradesh, Kameng F.D., Rupa to Jabrang, 23.v.1958, *G. Panigrahi 16053* (CAL, holotypus, isotypus). *Paratypi*: Kameng F.D., 2 - 2.5 miles from Rahung, 5900', 5.v.1957, *R.S. Rao 7430* (ASSAM, CAL); Kameng F.D., Nyukmadong to Dirang Diong 2.vi.1957, *R.S. Rao 8087* (CAL); Kameng F.D., Morsing, 16.vi.1958, *G. Panigrahi 15728* (ASSAM); Kameng F.D., Shergaon to Jegaon, 20.v.1958, *G. Panigrahi 15917* (CAL).

Shrub, *c.* 3m high; branches and branchlets subterete; young parts yellowish pubescent, glabrous when mature; bark thin, dark brown; internodes 2-16 cm long. Leaves decussate-opposite, sometimes subopposite, ovate, obtuse or subcordate at base, irregularly and distantly serrate along margins with acute serrations, shortly acuminate at apex, 6-14 x 3.5-10 cm, chartaceous, dark green, sparsely pubescent especially on nerves beneath, 3-nerved at base; lateral nerves 4-5 pairs; petioles terete, slender, 1-6 cm long, densely pubescent. Capitula terminal, *c.* 5 x 7.5 cm; peduncles obtusely 4-angular or subterete, 1.5 - 5 cm long, pubescent; bracts foliaceous, ovate, *c.* 1.6 x 1 cm; bractlets linear-elliptic or oblong, *c.* 1.5 x 0.4 cm, pubescent. Flowers numerous, compact: pedicels 4-5 mm long. Calyx tubular-campanulate, *c.* 7 x 5 mm, 5-toothed; teeth subequal, triangular, *c.* 3 x 2 mm, pubescent outside. Corolla subinfundibular, 5-lobed, white with rose or pink tinge; lobes subequal, obovate or suborbicular, obtuse, *c.* 5 x 4 mm; tube narrow, slightly curvate, 4-6 x 1-2 mm, glabrous. Stamens 4, didynamous, attached at or below mouth of corolla tube; filaments slender, glabrous, exserted, 6-10 mm long; anthers oblong, *c.* 0.15 mm long, 2-loculed, dark brown, glabrous. Ovary oblong, *c.* 2 x 1

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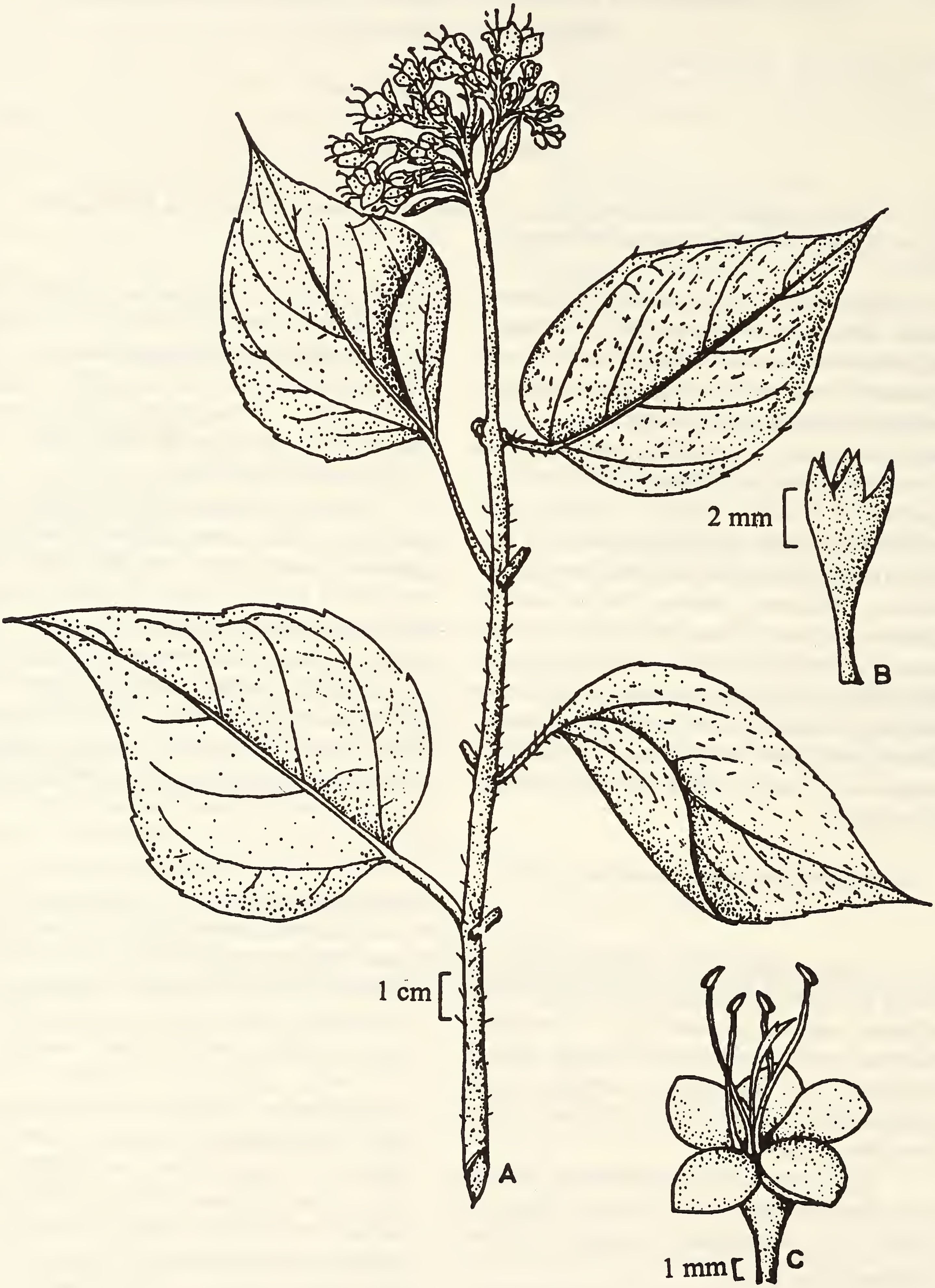
2 mm
B
1 cm
A
1 mm
C

Fig. 1. *Clerodendrum panigrahianum* sp. nov.: A. Habit; B. Calyx; C. Flower.

mm, 4-lobed, glabrous; style slender, minutely 2-lobed; lobes subulate, unequal, glabrous. Fruit not seen.

Flowers: March - June.

Habitat: Evergreen forests, *c*, 1960 m.

Distribution: Kameng Forest Division, Arunachal Pradesh.

Clerodendrum panigrahianum is allied to *C. bracteatum* but differs from it as shown in Table 1.

Etymology: The species is named after Dr. G. Panigrahi, formerly Joint Director, Botanical Survey of India, Calcutta, who has collected extensively in northeastern India and greatly contributed to its botany.

ACKNOWLEDGEMENTS

We thank Dr. N.P. Balakrishnan, formerly Joint Director, Botanical Survey of India (BSI), Coimbatore, for facilities and Dr. V.J. Nair, Deputy Director, BSI, Coimbatore, for the Latin diagnosis. A.R. is grateful to the Director, BSI, for a research fellowship and to the officers-in-charge of CAL and ASSAM, for facilities and loan of specimens.

TABLE 1

COMPARISON BETWEEN *C. BRACTEATUM* AND *C. PANIGRAHIANUM*

Character	*C. bracteatum* Wall. ex Walp.	*C. panigrahianum* sp. nov.
1. Leaves	ovate-lanceolate, entire along margins	ovate, distantly and irregularly serrate along margins
2. Peduncles	5-15 cm long with 1-3 capitula	1-4 cm long with one capitulum
3. Flowers	few, lax, in simple cymes, white	numerous, in condensed heads, white with pink or rose tinge
4. Calyx	campanulate, divided to half its length or more	tubular campanulate slightly, divided *c*. 5 mm long
5. Corolla tube	*c*. 5 cm long	

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HEDYCHIUM RAOII PAL ET GIRI - A NEW SPECIES OF ZINGIBERACEAE FROM ARUNACHAL PRADESH, INDIA[1]

G.D. Pal and G.S. Giri[2]

(*With five text-figures*)

A new species of the genus *Hedychium* Koen. is described below with illustrations. A tabulated key for the allied species is also appended.

Hedychium raoii Pal et Giri, sp. nov. (Figs. 1-5).

Proxime affinis *H. robusto* A.S.Rao et P.K. Hajra sed foliis sessilibus, infra adpresse pilosa, 3-4 floribus inclusis in bractea, calyce divisa ad medium vel infra medium, corollae tubis bracteis aequilongis vel eis 2-4 mm brevioribus, staminodiis lateralibus anguste lanceolatis, labio anguste obovato vel oblanceolato, apice penitus bilobo.

Typus: Holotypus lectus a G.D. Pal ad locum Arunachal, Inferior Subansiri, Yazali - Kimin Road, 20 km e Yazali, 700 m, die 20.ix.1983, sub numero 1254A et positus in CAL. Isotypus 1254B in Cal. Isotypus 1254C in ARUN.

Perennial rhizomatous herbs, 1.25-1.5 m tall. **Rhizomes**: tuberous, tangled, covered with scales, white or pinkish white inside, aromatic, 3-4.5 cm in diameter, segments subcylindric, 1-2 cm apart, *ca* 2.5 cm in diameter; roots stout, fibrous. **Leaves**: several, sessile, lanceolate to oblong-lanceolate, (40-) 45-55 (-62) cm long, (6-) 7.5-9 (-10) cm broad, base acute to subacute, apex acuminate to long acuminate, margins entire; subcoriaceous, glabrous above, white pubescent throughout beneath, hairs dense along the midrib; turning dull green above and greyish-brown below on drying; midrib prominent beneath, secondary nerves more or less prominent on both surfaces; ligules membranous or papery, oblong, 2-3.5 x 1-1.5 cm, sometimes bilobed, prominently nerved, pubescent without, greenish. **Spikes**: stalked, stalks 4-6 cm long, ridged, sparsely hairy, greenish; rachis 25-40 cm long, lax-flowered, ridged, sparsely pubescent, green; lowermost bracts empty, oblong-acuminate, 4-8 x 0.8-1.2 cm; floral bracts spirally arranged 20-30 per spike, lower strongly convolute, upper loosely convolute or nearly flat, oblong, (3.8-) 4-4.5 (-5) cm long and (1-) 1.2-1.5 (-1.8) cm broad, apex acute or subrounded, base clasping, margin membranous, sparsely to densely pubescent without, particularly towards base and apex, becoming glabrate with age, green to pale green, each bract enclosing 3-4 successively opening flowers; bracteoles as long as or 1-2 mm longer or shorter than bracts, appressed whitish pilose without, margin scarious, pale green or whitish green. **Flowers**: white, fragrant; calyx tubular, as long as or slightly longer than bracts, 4.7-5 cm long, split on one side upto below the middle, apex bifid, sparsely pubescent without, hairs more at bifid apex, margin ciliate, nerves prominent, membranous, greenish-white; corolla-tube narrow cylindric, as long as or 2-4 mm shorter than bracts, 3.8 - 4.5 cm long, 1.75-2.25 mm diam., glabrous, white; lobes linear, straight or twisted, 3.5-4.5 cm long, 1.25-1.5 mm broad, anterior lobe usually longer than the lateral lobes; lateral staminodes narrowly lanceolate, 3.5-4.2 x 0.4-0.6 cm, erect or reflexed, apex obliquely acute, margin subentire or repand, pinnately veined; lip narrowly obovate or oblanceolate, 4.5-4.7 x 2-2.5 cm, spreading or shallowly concave, margin wavy, distinctly clawed, bilobed, sinus 1-1.2 cm deep, lobes triangular or ovate-acute, parallel-veined; stamens 2-2.2 cm, shorter than

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[1] Accepted October, 1996.

[2] Botanical Survey of India, Arunachal Field Station, Itanagar-791111.

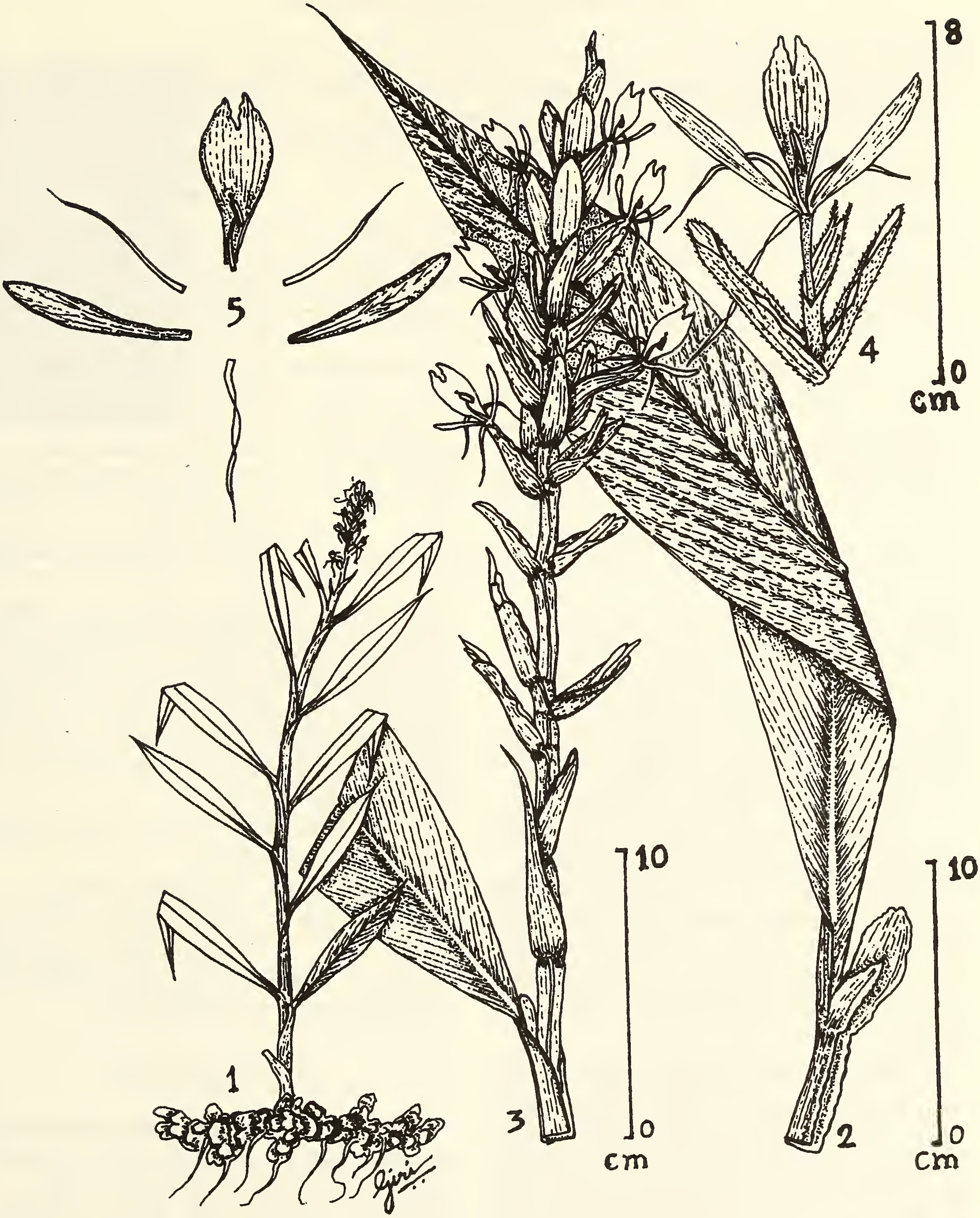
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Fig. 1-5: *Hedychium raoii* G.D. Pal & G.S. Giri sp. nov. 1. Habit (diagrammatic); 2. Leaf; 3. Inflorescence; 4. Flower with bracts and bracteoles; 5. Perigone with stamen.

TABLE 1

KEY TO THE SPECIES OF *HEDYCHIUM* KOEN.

H. dekianum A.S. Rao et D.M. Verma	*H. raoii* G.D. Pal et G.S. Giri	*H. robustum* A.S. Rao et P.K. Hajra
1. Leaves sessile, upper surface glabrous, lower surface appressed silky hairy.	Leaves sessile, upper surface glabrous, lower surface appressed silky hairy throughout, hairs more dense along midrib.	Leaves petiolate, upper surface hairy, lower surface hairy along nerves only.
2. Spikes 10-17 cm long, condensed, containing 25-35 bracts.	Spikes 30-40 cm long, lax, containing 20-30 bracts.	Spikes 20-32 cm long, lax, containing 12-22 bracts.
3. Bracts each enclosing 3-9 flowers.	Bracts each enclosing 3-4 flowers.	Bracts each enclosing 9-11 flowers.
4. Calyx slightly shorter or longer than bracts, deeply split.	Calyx as long as or slightly shorter than bracts, split at or below the middle.	Calyx longer than bracts, split much above the middle.
5. Corolla-tubes exceeding the bracts by 1.2-2.3 cm	Corolla-tubes as long as or 0.2-0.4 cm shorter than bracts.	Corolla-tubes exceeding the bracts by 1-2.5 cm.
6. Lateral staminodes spathulate, 2.5-3.7 x 1-1.6 cm	Lateral staminodes narrowly lanceolate 3.5-4.2 x 0.4-0.6 cm.	Lateral staminodes spathulate, 4.5 x 1.5 cm
7. Lip suborbicular, 3-3.7 x 2.3-3.4 cm, shortly clawed, bilobed, sinus 1.5-2 cm deep, lobes suborbicular, pale yellow blotches at base.	Lip narrowly obovate or oblanceolate, 4.5-4.7 x 2-2.2 cm, distinctly clawed, bilobed, sinus 1-1.2 cm deep, lobes ovate-acute, blotch absent.	Lip suborbicular or broadly spathulate, 4.5-5 x 3.5-4 cm, shortly clawed, rounded or truncate but not bilobed, pale yellow blotch at the middle.
8. Stamens 1-2 cm longer than the lip.	Stamens 2-2.2 cm shorter than the lip.	Stamens 1.5-2 cm shorter than the lip.

the lip, filaments 1.2-1.5 cm long, deeply channelled enclosing the style; anthers linear, 0.8-1 cm long, pink; ovary subglobose, about 2 mm in diameter, trigonous, glabrous; style 6.3-6.8 cm long, glabrous; stigma turbinate, papillose, green. **Capsules**: not seen.

Flowering: September - October.

Ecology: Grows in moist but open areas near streams or along moist forest fringes.

Distribution: INDIA: Arunachal Pradesh: Lower Subansiri dist., Yazali-Kimin road, 20 km from Yazali towards Kimin, 700 m, 20.ix.1983, G.D. Pal 1254A (Holytype-CAL). Isotypes: Ibid. G.D. Pal 1254B (CAL); Ibid. G.D. Pal 1254C (ARUN).

Note: The new species is closely allied to *Hedychium robustum* A.S. Rao & P.K. Hajra, but can be distinguished by its sessile leaves throughout appressed hairy beneath, bracts enclosing 3-4 flowers, calyx split at or below the middle, corolla-tube as long as or 2-4 mm shorter than the bracts, lateral staminodes narrowly lanceolate and lip narrowly obovate or oblanceolate with deeply bilobed apex. The new species also comes closer to *H. dekianum* A.S. Rao & D.M. Verma but can be easily recognised by its long lax spikes, narrowly lanceolate staminodes, oblanceolate or narrowly obovate lip and smaller stamens, which are always 2.2-2.7 cm shorter than the lip.

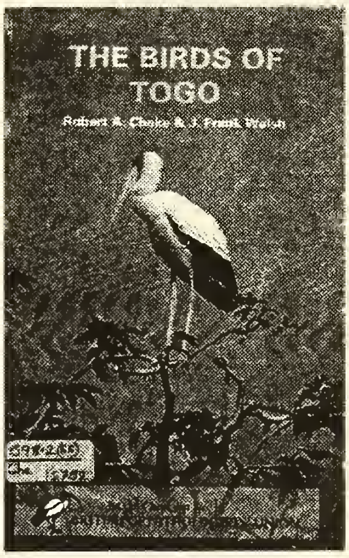
A tabulated key for the three species mentioned is given above.

Etymology: The specific epithet of this beautiful taxon is given in memory of the late Dr. A.S. Rao, Joint Director, Botanical Survey of India in honour of his valuable contribution to the flora of North-Eastern India.

ACKNOWLEDGEMENTS

The authors are thankful to the Director, Botanical Survey of India (BSI), Calcutta for facilities, to the Scientist incharge, Arunachal Field Station, Itanagar for encouragement and to Dr. N.C. Majumder, ex-Scientist SE, BSI, Calcutta for the Latin diagnosis of the taxon.

REVIEWS



1. THE BIRDS OF TOGO by Robert A. Cheke & J. Frank Walsh. B.O.U. Check-list No. 14 British Ornithologists' Union U.K. 1996. pp i - xii + 1-212, (25 x 15.5 cm), 53 colour plates and 9 maps. Hardback price £22.

Togo is a small country of 54,390 sq. km. wedged between Ghana and Benin in West Africa. This ancient land of Ewé tribe was devastated by the slave trade by the Danes, Dutch, British and French, during the 18th and 19th centuries. Between 1884 and start of the first world war, Togoland, as it was formerly called, was a German protectorate. After the Germans were defeated in the first World War, the Treaty of Versailles required Germany to relinquish Togoland. This tiny country was partitioned in 1919 by the French and British. After the United Nations monitored plebiscite in 1956, British Togoland became part of Ghana, but French Togoland became a self-governing republic within the French community. Finally in 1960, the Republic of Togo was born as an independent country with Lomé as its capital.

As tiny Togo has seen numerous changes in its borders, its ornithological history is quite confusing. Many places from where the birds were collected in former Togoland do not occur in the present Togo. Further confusion is created in museum specimens due to change in names, and sometimes by two places having the same name. For instance, Germans named an outpost as Bismarckburg in Togo. A town with a similar name is present in Tanzania.

Although located in West Africa, Togo is basically a semi-arid country, with about 1500 mm rainfall. More than 90% of the land is covered with savanna, only 7.2% is lowland forest. Togo also suffers from the usual negative environmental factors of an underdeveloped country: low literacy rate, high human density (64 per sq. km), rapid population growth (3.6% per year), rapid destruction of original vegetation and uncontrolled hunting.

This book forms a part of a series of checklists of birds from countries or places where not much work has been done. Fourteen check-lists have been published by the British Ornithologists' Union and three are under preparation. The authors Dr. J. Frank Walsh and Dr. Robert A. Cheke have listed 624 species for Togo. Both have spent considerable time in Togo, and even used a helicopter to visit remote areas not visited by earlier workers.

Scientific names, English and French names, status, distribution, abundance, habitat and, when applicable, breeding status in Togo, are given for each species. Many records are based on the authors' own previously unpublished observations, but a thorough literature survey (255 references), checking of specimens from seven museums, and unpublished notes of 20 observers are also used to describe 624 bird species.

The production quality of the book is excellent. I could not find any typographical mistakes. Maps and colour photographs are good and informative. I particularly liked the pictures of standard-winged nightjar *Macrodipteryx longipennis* and jacana *Actophilornis africana.* I wish there were more pictures of birds from this ornithologically rich but poorly known country.

ASAD R. RAHMANI

2. INDIAN DIRECTORY OF ENVIRONMENTAL ORGANISATIONS. Edited by Vandana S. A.P.H. Publishing Corpn., New Delhi, 1997. pp. 362 (25.5 x 19 cm) with lists of Environmental NGOs, Important Public Sector and Private Sector Organisations, Indian Universities, Environmental Activists, Standards for Cleaner and Greener Environment, Environmental Consultancy Organisations, Environmental Enactments, Pollution Control Boards, Testing Laboratories, Checklist of Environmental Management Systems. Price Rs. 800/- (Hardback).

The publication is an attempt to list environmental NGOs and organisations within the covers of one book. The approach is lackadaisical, illustrated by such gaffes as "the average Briton is said to **consumer** over **51 b** of additives a year". The author obviously means that the average Briton consumes over 5 lb. of additives a year ! At several places the monetary units have been overlooked while quoting figures, even units of temperature have been omitted. The book is not exhaustive and appears to have been published in a hurry without an appropriate editorial effort to keep out the innumerable mistakes and faux pas.

The topics covered in the introduction are wide and address almost all the major issues confronting humanity today, but the abrupt shift from one subject to another is jarring. Thus, while reviewing the Ramsar Convention there is a surprising deviation to the issue of recycling of wastes !

The editor has taken the liberty to change names of organisations, *viz.* Bombay Natural History Society has been referred to as Mumbai Natural History Society (BNHS) ! Bombay Environmental Action Group as Mumbai Environmental Action Group (BEAG). The innumerable and slovenly mistakes are in poor taste considering that the book will now form a standard reference text. Some examples, WWF For Nature - India, **Kothapur** Divisional Officer; Association for **Urral**, Social and Health Affairs; Gujarat **Aurved** University; **Aanti**-pollution Engineers; Indian Journal of **Genertics** and Plant Breeding; Advancing **Frontirs** of Plant Science; Zafar **Futchally**, Moitaka; Wildlife Association of **South Indian**; Newsletter For **Birodwatchers** !

Though the various methods of measurement of pesticidal residues as set out by the Union Ministry of Health & Family Welfare has been discussed cursorily, no mention has been made of a very important and active laboratory in Lucknow, the INDIAN TOXICOLOGICAL RESEARCH CENTRE.

In the chapter "Leading Environmental Consultancy Organisations in India", BNHS has not been listed inspite of its very active EIA cell and its contributions to such studies over the years. It is also not mentioned in the National Register of Environmental Consultancy Organisations. In the list of important journals the BNHS Journal has been overlooked though 'Hornbill' is mentioned.

It defies logic to list Important Public Sector and Private Sector Organisations in India. How do they qualify as Environmental Organisations ? Similarly the list of International Environmental Organisations is unnecessary considering that the publication seeks to list Indian Environmental Organisations. It appears to be an attempt at 'fleshing' out the book !

Moreover, the publication is exorbitantly priced at Rs. 800/- which is beyond the reach of an average environmentalist. Libraries may order a copy if they are willing to spend additional time in rectifying the myriad errors.

S. ASAD AKHTAR

3. WORLD DIRECTORY OF ENVIRONMENTAL ORGANISATIONS. Edited by Vandana S. pp. 606 (25 x 18.5 cm). A.P.H. Publishing Corpn., New Delhi, 1997, with lists of Environmental NGOs, Public Sector & Private Sector Organisations, Indian Universities, Testing Laboratories, Environmental Activists, Environmental Journals, List of Universities, Environmental Consultancy Organisations, Standards for Cleaner and Greener Environment, Voluntary and Non Governmental Organisations, International Register of Environmental NGOs, Checklist of Environmental Management System. Hardback, Price Rs. 1000.

The publication is an avatar of the Indian Directory of Environmental Organisations. The contents are similar, except for an enhanced list of Environmental Organisations based in foreign countries, mainly in the U.S.A, including a list of American Universities and Environmental Journals of U.S.A. A list of leading Pollution Control Equipment manufacturers from United Kingdom has also been provided. The book includes a list of NGOs in the Asia Pacific region. Like its earlier version, editorial faux pas are prominent and make a bad first impression.

Beside the innumerable editorial mistakes, the listing of unnecessary items has continued, at the cost of precious newsprint. The same space could have have been used for providing more relevant information. The General List of Pollution Control Equipment Manufacturers needs to be substantiated as it can be to the commercial advantage of the manufacturers at the cost of environmental propriety.

In short, the publication is a good attempt at providing environment related information within the covers of a single book, though the slovenly editorial effort is unfortunate. The Directory will provide basic information to concerned environmentalists and be of assistance in their networking programmes.

S. ASAD AKHTAR

4. FISH REPRODUCTION by N.K. Agarwal (1996). Published by APH Publishing Corpn., 5, Ansari Road, Darya Ganj, New Delhi-110 002 (28.7 x 21.9 cm) pp. 157 Price Rs. 500/-

Here is a book focussing purely on the reproductive biology and environmental influences on spawning activities of the snow-trout *Schizothorax plagiostomus* (Heckel), an economically important protein-rich fish of the snowfed River Alaknanda of Garhwal Himalaya.

It presents materials on methods for pisciculture experts and research students — like morphohistological and histochemical studies of the gonads. It gives a deeper insight into testicular and ovarian cyclicity, and emphasises field studies like the ecology of the spawning ground and the interaction of various environmental factors which aid spawning and breeding.

The book stresses that such fish as this inhabit cold water streams and lakes could be a challenge to the modern fishery industry if new experimental techniques like induced breeding and genetic manipulation could be applied to improve their fertility.

It is good comprehensive reading material. Unfortunately there are numerous errors.

R. GHOSH

MISCELLANEOUS NOTES

1. THE JACKAL, *CANIS AUREUS* LINN. — A NOTE ON SOME VARIATIONS

The jackal *Canis aureus* Linnaeus shows geographic variations in coat colour. R.C. Wroughton, 1916 described *Canis indicus* (with two subspecies - *Canis indicus indicus, Canis indicus kola*). He also reported *Canis naria* from India, and *Canis lanka* from Sri Lanka. Prater (1980) treated Indian jackals as a single species having three races (*Canis aureus aureus* Linnaeus, *Canis aureus indicus* Hodgson and *Canis aureus naria* Wroughton) and the Sri Lankan race as *Canis aureus lanka* Wroughton. The north Indian races are generally tawny but with their chin and throat white and underside paler or buff in colour. The grizzled pattern of the back is characteristic of the west-coast race (*Canis aureus naria*). However, occurrence of black variants of the species in North India were reported earlier (Prater, 1980).

A study of three jackals kept in captivity at the Parassinikadavu snake park, Kannur dist., Kerala indicate that the colour variation and certain other features like size of the animal and its muzzle shape may not be entirely of geographical significance, as all the three individuals obtained from the same district exhibit profound differences in these characters.

One individual *almost black with very few grey hairs has a light area around the eyes and a white spot on the chest. This individual appeared to be more aggressive. Black variants reported earlier suggest the possibility that it might be a cross between a dog and a jackal. This one is also the largest among the three. Occurrence of hybrid dog-jackals was previously reported by Donald (1948). The second* individual is like that of the north Indian race in colour and is smaller than the black one, but a little larger than the third* one. The smallest individual among the three, characterised by the grizzled colour, though typical of the west-coast race, is peculiar in having its tail tip white in colour, a feature non-characteristic of the species.

Since all the three jackals observed are obtained from the same area (Kannur dist. Kerala), they augment the need for further study of variations in populations and of possible hybrid forms of jackals.

The author is grateful to the Director, Zoological Survey of India, Calcutta and the Officer-in-Charge, Zoological Survey of India, Calicut for facilities and encouragement. He also thanks the authorities of Parassinikadavu Snake Park for the help rendered.

* A photograph of all three variants has been provided by the author but is not of printable quality. — Ed.

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2. DIET OF THE BROWN PALM CIVET (*PARADOXURUS JERDONII*) IN KALAKAD-MUNDANTHURAI TIGER RESERVE, TAMIL NADU

On 19 June 1995 at about 0630 hrs when we were driving down from upper Kothayar to Kakachi, Kalakad Mundanthurai Tiger Reserve, we noticed a small brown animal lying by the side of the road. On closer examination we found it to be the brown palm civet (*Paradoxurus jerdoni*). It had a uniform brown coat with a white tail tip. The animal was fresh and must have died just a few hours earlier and fortunately it was not run over by any vehicle.

Palm civets are omnivorous and their diet includes varieties of fruits (Prater 1980, THE BOOK OF INDIAN ANIMALS, Mumbai). We give below the list of items identified from the stomach of the civet.

STOMACH AND COLON CONTENTS OF BROWN PALM CIVET

Species identified		No.
In stomach*		
Embellia sp.	fruit pulp	1
Elaeocarpus munronii	fruit+intact seeds	1
Snail with shell	Invertebrates	2
Earthworms	"	1
Unidentified undigested matter		3
In colon:		
Embellia sp.	intact seeds	1
Rubus sp.	seeds	20
		29

* a few sand particles were also found.

The list shows the omnivorous nature of the animal and the presence of intact seeds in the colon indicates that the animal can disperse seeds. It also shows that it is not necessarily arboreal; this is indicated by the presence of earthworms and *Rubus* seeds which are available at ground level.

ACKNOWLEDGEMENTS

We acknowledge the financial support provided by TERI and MacArthur Foundation, USA for work in Kalakad. We thank Kannan and Ramesh for helping us with the dissection of the animal.

November 17, 1997

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3. ON THE OCCURRENCE OF THE TIGER *PANTHERA TIGRIS* IN SIKKIM

The first positive occurrence of tiger in Sikkim was reported by Col. F.M. Bailey in 1924 from Karponang, east Sikkim, where its pugmarks were seen. It had been killing ponies and yaks. Shooting was attempted unsuccessfully but the animal was seen by the beaters. It was then reported to have crossed Lagyap (3500 m) between Gangtok and Natu La and reached Tsomgo (3800 m), killing livestock on the way and a yak at Tsomgo. When driven off the kill it crossed a 4000 m ridge into the Yelli Chu valley and thence into the Dikchu valley where it was killed (Bailey, 1939 *JBNHS* 41: 166).

The first recorded sighting of the tiger in Sikkim was in 1934 by the Political Officer Mr. F. Williamson, who sat up over a mule kill at Lagyap and actually saw the animal (Battyi, 1939 *JBNHS* 41: 165). It was speculated that the tiger, probably a pioneer from the lower elevations either returned or went over the Natu La into Chumbi valley after being shot at. To corroborate the latter hypothesis a male yak was found killed there, with fang marks on the throat.

In April 1938 Lt. Col. F.H. Lister came across a fresh tiger skin at Lachung in north Sikkim (Lister, 1938 *JBNHS* 40: 553). In December 1994 during my visit to Lachung, I came across the skull and lower jaw of a tiger in possession of an old hunter Mr. Thendup Lachungpa and photographed it. He reported the skull to be about 40 years old. Another local person also reported sighting of a large male tiger in the forest below Yumthang around 50 years ago.

The route of the tiger from east Sikkim towards the north has been documented by Mr. Chezung Lachungpa, Divisional Forest Officer, Wildlife Circle for the last 20 years, from sporadic local reports of sightings, kills, compensation paid by the Government and presence of pugmarks. Plaster casts were lifted from the prints whenever located and are now in the State Forest Department office at Gangtok. Usually the reports were of only one animal which probably came in from adjacent West Bengal or Bhutan to occupy suitable territory.

Today we have probably lost the tiger in Sikkim. The lush jungle routes traversed by the tiger are either no longer in existence or under heavy military occupation. Occasional reports of tiger from Melli, south Sikkim usually turn out to be leopard (*Panthera pardus*) kills.

February 18, 1997

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4. EARTHWORM IN THE DIET OF LEOPARD *PANTHERA PARDUS*

The panther will kill and eat anything. It can overpower with safety, cattle, deer and monkeys, the smaller beasts of prey and large rodents like the porcupine. Its bill of fare is extended to include birds, reptiles and crabs (Prater, 1965; THE BOOK OF INDIAN ANIMALS). A leopard has a great tendency to digest each type of flesh including some cartilaginous parts but is unable to digest hair, hooves and bones which are left as such in its droppings.

A general study of scats was carried out wherever they were found, in Chail Wildlife Sanctuary and the University Campus (Nauni). Undigested bone, hair, hooves and even green parts (leaves) were found in droppings at Chail. But the most interesting finding in the scats of leopard is of the earthworm* which was collected from the University Campus near the dairy farm in December, 1996.

Earthworms are cold blooded annelids and nocturnal in habit, living in burrows during the day but coming out at night in search of food. Numerous earthworms were seen in the morning hours along the roadside from the University Library to the dairy farm in winter before snowfall (mainly Nov.-Dec.). Still, we could not get a satisfactory reason for the consumption of earthworms by leopard. It is known that a leopard can devour and digest each type of flesh but it is a mystery why earthworms were not digested by the leopard.

*Photograph — not of printable quality — Ed.

August, 5, 1997

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5. WILD WATER BUFFALO *BUBALUS BUBALIS ARNEE* IN DIBANG VALLEY DISTRICT OF ARUNACHAL PRADESH

(*With one text-figure*)

The Asiatic wild water buffalo *Bubalus bubalis* Linn. *arnee* Kerr, is among the globally threatened species. The bulk of the known population occurs in India. An account of its status in northeast India, the only stronghold of the species, is given in Choudhury (1994). In the report, occurrence of a small and scattered population in Dibang Reserved Forest (RF) of Arunachal Pradesh has been mentioned.

Here I report the past and present status of the species in the entire Dibang Valley dist. of Arunachal Pradesh, as ascertained during field visits between 1992 and 1994.

Till the early 1970s, wild buffalo was widespread all over the lower areas of Dibang

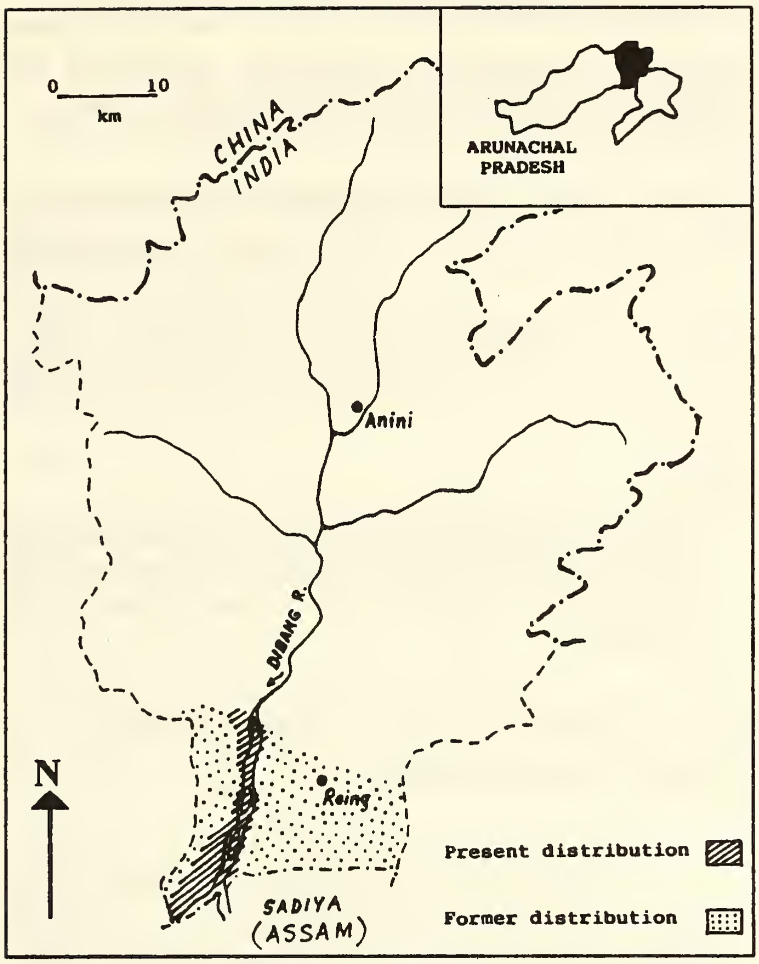

Fig. 1. Map of Dibang Valley district of Arunachal Pradesh showing the past and present distribution of wild water buffalo

Valley district beginning from near Nizamghat to the inter-state border with Assam, mostly in the *chapori* (riverine tracts) of the Dibang, Deopani and the Sesseri rivers. From the late 1970s, new settlements began coming up in many of the plains areas especially between Roing and Santipur and in Bomjir and Bijari. Gradually the number of *khutis* (= cattle camps, mostly run by Nepalis and Biharis) also increased on the *chaporis* of the Dibang river. These factors along with growth of population have resulted in degradation and alteration of habitat. Availability of firearms has resulted in an increase in poaching for meat as the local tribes, both Adis and Idu Mishmis relish it. The buffalo population declined drastically before being surveyed properly. The Idu Mishmis call it *Maji kara*.

In March 1993, I found a few solitary bulls near Nizamghat (200m elevation), where the Dibang river devouches onto the plains (at 28°15' N, the northernmost site in the distribution range of the species). There were no *khutis* in the vicinity and the possibility of any feral animals in the area was remote. The area is in Sirkee proposed RF. Then I examined six horns, of 4 males and 2 females, at Bomjir (190m elevation), all these were shot by the local tribal hunters during the last half-a-decade from the *chaporis* of the Dibang river. They also shot 2 feral animals which deserted the *khutis*.

It is difficult to make an accurate population estimate as the animals are extremely shy due to regular persecution and are rather thinly distributed. However, after we visited all the known and potential areas and interviewed local hunters, graziers of the *khutis* and other tribal villagers, it can be safely assessed that there are less than 10 animals in Sirkee proposed RF and adjacent areas of Deopani RF. They affect the grasslands on the Dibang and Deopani rivers and only occasionally wander into the nearby woodlands including the southwestern edge of Mehao Sanctuary. In Dibang RF including the adjacent Kerim RF, a larger population of 40 to 60 occurs, as the habitat is still fairly large and contiguous with some of the buffalo-bearing areas of East Siang dist. and Tinsukia dist. (Assam). In the *chapories* of Sesseri river, only an occasional stray individual is encountered. The total habitat available for wild buffalo in the district is about 120 sq. km (Fig. 1).

Presence of domestic buffaloes in the *khutis*, especially in the lower reaches of the Dibang river, poses a permanent problem to the small wild population because of the potential danger of diseases like anthrax, foot-and-mouth and rinderpest. However, contamination of wild stock due to interbreeding is a remote possibility, as domestic males are usually not kept in the *khutis*. Domestic animals going feral are immediately brought back because they are too valuable to their owners. In case of failure, the local tribals track and shoot them, as they find feral animals easier to shoot than the pure wild.

While habitat destruction continues to be a threat, poaching is taking its toll and unless conservation measures are implemented the future of these animals is bleak. Parts of Dibang RF, Kerim RF and Sirkee proposed RF (totalling 202 sq. km) I have been recommended for a national park for its importance as the habitat of Bengal florican *Eupodotis bengalensis*, white-winged wood duck *Cairina scutulata*, tiger *Panthera tigris*, elephant *Elephas maximus*, of course the wild buffalo and as an important flyway of migratory waterfowl, including the common crane *Grus grus* (Choudhury, 1996).

April 1, 1997 ANWARUDDIN CHOUDHURY
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6. FORAGING ASSOCIATION OF WHITE STORK *CICONIA CICONIA* WITH BLACKBUCK *ANTILOPE CERVICAPRA*

We visited Velavadar Blackbuck Sanctuary and National Park (Bhavnagar dist. Gujarat) on November 5, 1988. At 0830 hrs, there were 500 blackbuck *Antilope cervicapra* scattered in small groups around the guest house. Though at a close range, the blackbucks were camouflaged against almost dried grass whereas more than 50 white storks *Ciconia ciconia*, which were either foraging in the grass or flying across a short distance, were quite conspicuous. We saw atleast 6 storks walking behind the blackbuck within 2 m distance and capturing disturbed prey. Since the storks were attending separate groups of blackbucks, this foraging association was not easily noticeable. The storks frequently changed the feeding site, pursuing one group of blackbuck after another. This foraging association was exactly the same as that of cattle egret *Bubulcus ibis* following cattle.

To capture disturbed prey, the white storks are known to follow fire (Hancock *et al.* 1992), plough in the crop field (Pinowski *et al.* 1991) and other mammals (Hancock *et al.* 1992, Dean and MacDonald 1981). In Africa, white storks are known to associate with Cape buffalo, white rhinoceros, blue wildebeest, impala and domestic cattle (Dean and MacDonald 1981). However, in India, white storks are not reported to associate with any wild or domestic mammals and hence this is the first such report.

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PINOWSKI, J., B. PINOWSKI, R.D. GRAFF, J. VISSER & B. DZIURDZIK (1991): Influence of feeding habitat on prey capture rate and diet composition of White Stork *Ciconia ciconia* (L). *Zakland Ochrony Przyrody I, Zasobow Naturalnych Polskej Akademii Nauk, Studia Naturae - Seria A*: 59-83.

7. RECORD OF *CICONIA CICONIA ASIATICUS* FROM INDIAN TERRITORY

We had procured a pair of white stork *Ciconia ciconia* from a bird dealer at Calcutta in April 1969. Another pair was procured from Kankaria Zoo, Ahmedabad in June 1976, while the third pair was brought from the same zoo in 1985. However, between 1976 and 1985 one stork died, but its record is not traceable. In December 1985, we realized that out of the total of five storks, one did not mix with the others and kept aloof. On closer observation we realised that the stork in question had red skin surrounding its eyes and lores. This character was in sharp contrast with other storks in the zoo, which had black skin in the same area. The bill colour was also bright red and bare gular skin was red and not black. This strange stork appeared slightly larger than other storks. The white storks with black skin around the eyes were certainly the nominate race *Ciconia ciconia ciconia* (Ali and Ripley 1983). However, we failed to find a description of the strange stork and hence its race/subspecies.

In February 1996, during the Sálim Ali Centenary Seminar, one of us (BMP) showed a picture of the stork to Dr. Malcolm Coulter (USA) and Dr. Elena Mukhina (Uzbekistan), who said that it could be the Central Asian White Stork *Ciconia ciconia asiaticus*. This subspecies is described by Hancock *et al.* (1992), who report that it is larger than *ciconia* and its bill is redder, upcurved, longer and heavier. However, they have not mentioned the colour of the skin around eyes. *C. c. asiaticus* is found in Turkistan, USSR, Uzbek SSR, Tadxik SSR, Kirgiz SSR, and Southern Kazakh SSR from Amu Dar'ya to ISSYK Kull and Lake Balkhash and extreme Western Sinkiang, China (Kashgar). Hancock *et al.* (1992) also state that this subspecies migrates through Afghanistan and winters mainly in the northern parts of the Indian subcontinent, mixing with birds of the nominate race from the Middle East. Ali and Ripley (1983) have shown breeding distribution of *C.c. asiaticus*, but they doubt the validity of the subspecies.

Hancock *et al.* (1992) reported that this subspecies winters mainly in the northern parts of the Indian subcontinent. We believe that the stork in our zoo must have been supplied by a Calcutta dealer. No Indian zoo has received white storks from any Russian Zoo and hence it is quite likely that *C. c. asiaticus* was trapped from the Gangetic plains of West Bengal or Bihar. After 1986 we have carefully watched all the white storks in the field for red skin around the eyes but have failed to trace even a single specimen, especially in Gujarat.

October 11, 1996

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8. OCCURRENCE OF THE WHITEWINGED BLACK TERN *CHLIDONIAS LEUCOPTERUS* IN RAJASTHAN

On April 9, 1996 we were watching a mixed flock of terns at Phulera lake, Jaipur and became immediately aware of four jet black terns. As we viewed them for more than fifteen minutes before they flew away, there was no doubt in our minds that they were indeed whitewinged black terns *Chlidonias leucopterus* in full breeding plumage.

The next day, on April 10, only one individual was present and we were able to shoot a picture of this bird despite the great distance.

So far there have been only three records of the bird from the western side of India, on the basis of which this tern is considered to be rare in this part of the country (Ali and Ripley, 1981, HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN Vol. III). This is the first record of the species in Rajasthan.

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9. AERIAL DISPLAY OF RUFOUS TURTLE DOVE *STREPTOPELIA ORIENTALIS AGRICOLA* TICKELL NEAR NAMBOL BAZAR, MANIPUR

On 20th May, 1996 at about 0530 hrs, I saw a pair of rufous turtle doves, *Streptopelia orientalis agricola* on a dry twig of a big tree enjoying the morning sun. Suddenly, one of them (probably a male) left the perch for an aerial show covering about one minute in three successive phases (or models). The first-phase flight was short, horizontal with gentle wing flapping and unsplayed tail. This was followed by a swift and forceful steep flight with rapid wing clapping, producing loud sounds, but tail slightly fanned out. In the third or final phase, it flew in gliding and coasting in a semicircle with both wing and tail fully fanned out. Only during this phase of flight could the white of the terminal fringe of tail be seen. On completing such a round flight, it alighted about two feet away from the other bird at first, but on the same branch, then gradually moved in mincing paces. No display call or aggressive attitude was exhibited by either bird. However, this activity may be a courtship display.

July 10, 1996 Kh. SHAMUNGOU SINGH
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10. AN INDIAN PITTA (*PITTA BRACHYURA*) TRAPPED IN A STANDARD SHERMAN LIVE TRAP

I studied the effect of rainforest fragmentation on small mammals by the removal method which consisted of 50 foldable Sherman live traps along five 5 x 10 m grids in a disturbed forest patch of the Indira Gandhi Wildlife Sanctuary, Tamil Nadu. The traps were baited with peanut butter and were designed for large bodied rats like the house rat (*Rattus rattus*), but are sensitive even for animals weighing as little as 8g. In the morning of 28th March 1995, while I approached a particular trap station, the box was shaking. The trapped creature made a few harsh sounds which confused me. To my surprise, there was an Indian pitta (*Pitta brachyura*) inside. After identifying the bird it was released at the same spot. I thought this record of particular interest because a) the bird stands higher than the mouth of the trap and b) the bird had either come for the bait of peanut butter or to feed on the insects or ants which had been lured into the trap by the bait. The Indian pitta primarily feeds and forages on insects, grubs and worms on the ground (Ali & Ripley, 1987 COMPACT HANDBOOK OF BIRDS OF INDIA AND PAKISTAN). Hence, it likely that the bird was attracted to the insects or bugs rather than to the peanut butter, although this needs to be tested. The incident occured in a totally degraded forest patch, where the food sources are scarce. The bird's normal ground foraging habit might have driven it to attempt to get food in this unusual manner.

August 20, 1996

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11. GOLDEN ORIOLE *ORIOLUS ORIOLUS* PREYING ON FLYING LIZARD *DRACO DUSSUMIERI* DUM. & BIBR.

On 8 January, 1996, during one of my field trips in the Western Ghats of Kerala, in a riparian habitat at Poringal Kuthu Dam near Vazhachal, I observed flying lizards *Draco dussumieri* in good numbers. Several trees had one or two lizards moving around the tree trunks. I was amazed to see the lizards in abundance. In that area on one of the trees I saw a golden oriole *Oriolus oriolus* holding its prey in its bill and beating it on the branch to devour it. I found that the prey in the oriole's bill was a flying lizard. According to THE HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, by Ali and Ripley (1983) the oriole is a frugivore, but occasionally eats insects. Whether the non-availability of fruits or the abundance of the lizard made the oriole go for the lizard is uncertain. In any case it is interesting to note that the flying lizard also forms an item of the golden oriole's diet.

March 23, 1997

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12. COMMON MYNA FEEDING A FLEDGELING KOEL

On 15 August, 1996, at about 1130 hrs I observed a common myna *Acridotheres tristis* feeding a fledgeling koel *Eudynamys scolopacea* in the compound of Girls High School at Mangaldoi, Darrang dist., Assam. The fledgeling flew down to the ground for feeding where the myna was waiting. Then in the afternoon, the same birds were seen again, this time on the tin roof of the school building. The fledgeling was very noisy, which in fact caught my attention on both occasions. While the type of food provided during the first observation could not be identified, the myna did not offer any food the second time, although the fledgeling flew down noisily and begged for food. Then the fledgeling flew back to a nearby tree.

The young koel was a female, as was evident from its plumage. The koel is a known brood-parasite, usually on the house crow *Corvus splendens* and the jungle crow *C. macrorhynchos*. Eggs have also been recorded from the nests of Chinese magpie *Pica p. seriea,* red-billed blue magpie *Urocissa e. magnirostris* and black-necked myna *Gracupica nigricollis* (Editor's footnote in Smith 1950). Smith (1950: *JBNHS* 49[2]: 304-305) recorded a very interesting case of black drongos *Dicrurus macrocercus* fostering a koel. This observation of common myna and koel seems to be the second published instance, the first being eggs of koel recorded by Stuart Baker from a common myna's nest (Cuckoo Problems, p. 197).

March 14,
1997

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13. MIMICRY BY COMMON IORA *AEGITHINA TIPHIA*

On 10th August, 1995, around 1300 hrs close to my residence, the repeated calls of a black drongo (*Dicrurus adsimilis*) attracted my attention. On investigation, it was found that a drongo was perched on a small tree nearby and was calling. Soon far more feeble, but similar calls were heard from another tree nearby by a male common iora. After a minute or so, the drongo departed but the iora continued imitating it for quite sometime.

This act of mimicry by the iora has not been recorded in the literature and is rather unusual for the species.

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14. UNUSUAL NEST LOCATION OF REDVENTED BULBUL *PYCNONOTUS CAFER* (LINN.)

A redvented bulbul (*Pycnonotus cafer*) made a nest inside a staff bus of the 'Space Applications Centre', Ahmedabad. In the first week of May, 1996 we found it sitting on a nest built on the luggage rack at the rear end of the bus. The bus is usually parked at the SAC campus, adjacent to Sundarvan but ferries passengers twice a day — in the morning and evening.

Interestingly, when the bus plied and was on the move for a couple of hours or more in the city, the bulbul continued sitting at the nest, undisturbed by the passengers. Four eggs were observed in the nest on 12 May, 1996. The bus driver reported 2 fledgelings from this brood in the last week of May. The bulbul's mate was also seen several times when the bus was parked. Possibly, this pair made more than one breeding attempt, because the nest was seen to be occupied as late as July end.

In the same bus, three other nests — two in the forepart of the luggage rack and one at the rear end were found — suggesting that this pair or maybe some other individuals had attempted nesting prior to the observed nests. One of these nests was taken to Sundarvan and examined closely. Whereas this particular nest fits the general description of a redvented bulbul's nest as given in Ali and Ripley (1983) HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, its somewhat 'mobile' location is unusual.

We thank Mr. Lavkumar Khacher for his comments and Mr. R.H. Bhatnagar, bus driver, for cooperation.

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15. POSSIBLE BREEDING BY ROCK THRUSH *MONTICOLA SAXATILIS* (LINN.) IN NORTH KASHMIR

The rock thrush *Monticola saxatilis* (Linnaeus) is believed to be a common passage migrant in Baltistan and Gilgit regions of north Kashmir (COMPACT HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Ali and Ripley 1987). It appears to nest occasionally in southern Baluchistan (THE BIRDS OF PAKISTAN, Vol. 2, Roberts, 1992). The only suggestion of its breeding in north Kashmir is

A.E. Ward's 1906 mention of birds collected "from Baltistan found in the summer." (*JBNHS* 17(2): 482). However, no dates are associated with this claim, and as migration through this area occurs at the very end of August into early September it is not clear if the birds collected were breeding or migrating.

A female rock thrush was observed by us on 8th and 9th August 1995, near Hopar in the Nagar Valley of Hunza, (36° 23' N Lat. 74° 43' E long.) for a total of three hours over two days. The bird was seen at an elevation of 3,400 m on an open grassy slope near a steep boulder-strewn hill. The bird showed strong site fidelity, returning when approached too closely and regularly chasing off black redstarts (*Phoenicurus ochruros*) that approached the rock walls of a corral.

While there was no definite proof of nesting, the female was an adult and exhibited strong site fidelity and territorial behaviour toward other birds. Our observations were made after the known breeding season but prior to the occurrence of passage migration through this region (late August and September). We submit that this is further evidence that the rock thrush *Monticola saxatilis* is at least an occasional breeder in the mountains of north Kashmir.

June 4, 1996

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16. RECORD OF SIBERIAN BLUE CHAT (*ERYTHACUS CYANE*) FROM PAURI GARHWAL, UTTAR PRADESH, IN THE WESTERN HIMALAYAS

On 29 May 1996 we were watching birds from the premises of a temple (altitude *c.* 1940 m) situated *c.* 120 metres above the town of Pauri (30° 0' N & 78° 47' E) in Pauri Garhwal dist. of Uttar Pradesh. The forest around consisted of tall, old specimens of fir (*Abies* spp.), oak (*Quercus* spp.), chir pine (*Pinus roxburghii*), spruce (*Picea* spp.), rhododendron (*Rhododendron* spp.) and deodar (*Cedrus deodara*). Around 0800 hrs, while observing a group of small flycatchers and white-eyes, I suddenly saw a bird flying in and settling on a branch of a chir pine tree. The bird sat about 10 metres in front of me at eye level. The morning being bright and sunny, I got a very clear look at the bird. The sparrow-sized bird had beautiful blackish blue and white plumage. I identified it as the Siberian blue chat (*Erythacus cyane*). I was familiar with the appearance of this bird from Ali and Ripley's *Pictorial Guide* Plate 81. While trying to identify an orangeflanked bush robin (*Erythacus cyanurus*) a few days earlier, initially I could only view its dark blue dorsal parts, a lighter supercilium, white underparts and the dark band from near the bill that extends over the eyes to the sides of the breast. I could not see its orange flanks and the faint greyish tinge on the lower breast. It looked very like the Siberian blue chat illustrated in Plate 81, but differed from it in having the supercilium. Later, when the bird moved, I saw the flank and breast and identified it as *Erythacus cyanurus.*

The bird I saw from the Pauri temple premises perfectly matched the illustration of the Siberian blue chat. Through my 8x30 binoculars I could clearly make out the lack of any trace of supercilium, rufous-orange patch on the sides and the faint greyish lower breast. I noticed the broad black band extending over the eye from the bill to the sides of the breast up to shoulder level. In *E. cyanurus* the band is blue. The slaty blue upperparts from forehead, crown to rump were concolorous, but the upper tail coverts were a little deeper in shade and slightly more glossy than the rest. I also saw that the entire underparts, from chin to under tail coverts and vent, were spotless white. The legs were light pinkish in colour. I had the *Pictorial Guide* in my hand while observing this bird. Since the bird is extremely rare in India, I checked the identifying features many times over till I was sure about its identity.

Ali & Ripley (1983a) give the distribution in India as - "A straggler in winter and during migration. Haldibari duars, Bengal 18 February 1932 (Inglis coll., Brit. Mus.); Manipur, a party in April (Hume)". In the footnote about *Erythacus cyane* it gives the following information - "A specimen in the Pinwill coll. (Brit. Mus.) is labelled Simla but 'Simla'is written in such a way that it evidently was not written at the time though it is Pinwill's writing'' (Whistler's MS). An observation by Magrath in Hazara in June (*JBNHS* 18: 197) certainly pertains to *Muscicapa leucomelanura,* as does one from Narkanda, c. 35 km NE. of Simla (von Pelzeln, *Ibis* 1868: 310). Ali and Ripley (1983b) give the distribution as ''Isolated records from Bengal duars, Manipur and S. Andamans".

My record from Pauri may point out that *Erythacus cyane* may be a straggler to Western Himalayas and there is a likelihood that the specimen from the Pinwill collection was correctly labelled.

September 17, 1996

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17. STATUS OF THE GHARIAL *GAVIALIS GANGETICUS* IN THE MAIN BRAHMAPUTRA RIVER

(*With one text-figure*)

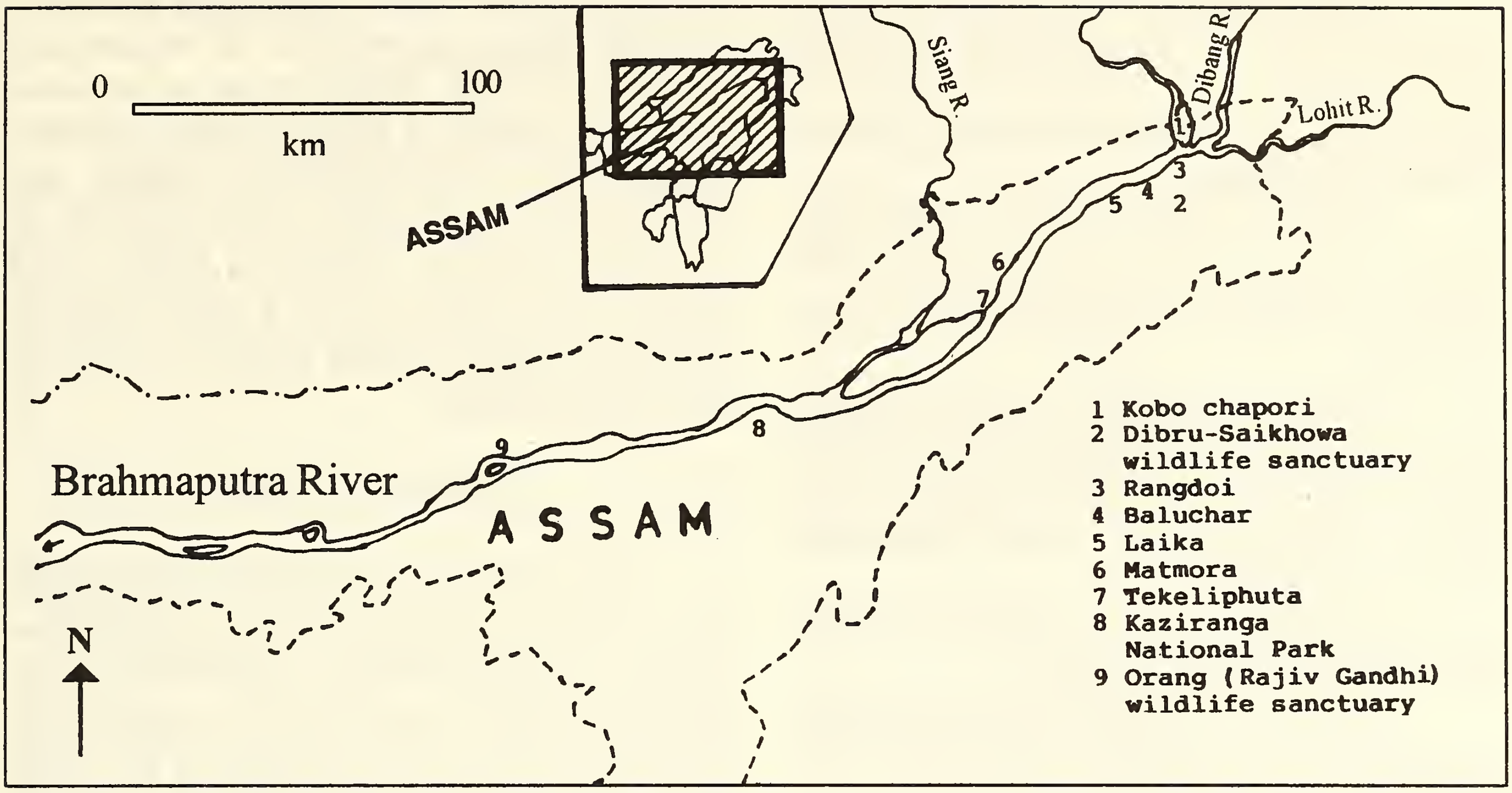
In the Brahmaputra river, the gharial *Gavialis gangeticus* was once fairly common (Cooper 1873), but now it is rarely seen and its future is bleak. In some recent works (Singh 1991; Whitaker and Basu 1992), its status in the Brahmaputra river was not dealt with in detail and its current status is unclear. Moreover, information provided by Singh (1991) referring to Singh, Kar and Choudhury (1984) does not seem to be based on actual field study. The only recent information on the species from a part of the river is from Choudhury (1992). Cooper (1951 a, b) covered the Barak river system, erroneously referred to by Singh (1991) and Singh, Kar and Choudhury (1984).

During the past decade, I carried out field work in different parts of the Brahmaputra river as part of a broader survey on wildlife. The data collected on the occurrence of the gharial are presented below.

c. 1979: One seen near Tekeliphuta, near Lakhimpur-Jorhat inter-district boundary, in the afternoon hours. It was about 2.5 - 3.0 metres long.

1981-83: A large gharial seen near Rangdoi, now part of Dibru-Saikhowa Wildlife Sanctuary, Tinsukia district; it was 4.5 - 5.0 m long.

1982: One seen near Baluchar, now part of Dibru-Saikhowa Wildlife Sanctuary, Tinsukia district.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1 Kobo chapori
2 Dibru-Saikhowa wildlife sanctuary
3 Rangdoi
4 Baluchar
5 Laika
6 Matmora
7 Tekeliphuta
8 Kaziranga National Park
9 Orang (Rajiv Gandhi) wildlife sanctuary

Fig. 1. Occurrence of the Gharial (*Gavialis gangeticus*) along the Brahmaputra river.

1982-83: One seen by Mising tribal people near Matmora, Lakhimpur district (Choudhury 1992).

1982-84: One caught in trap especially set up for the gharial near Rangdoi, now part of Dibru-Saikhowa Wildlife Sanctuary in Tinsukia district.

c. 1983: One seen basking on the river bank near Dibru-Saikhowa Wildlife Sanctuary: it was about 4 m in length.

1986: (a) Two seen near a pool of the river, in January-February. They were of the same size (about 2 m long) and were basking near Baluchar, now part of Dibru-Saikhowa Wildlife Sanctuary, Tinsukia district.

(b) One seen near Tekeliphuta, near Lakhimpur-Jorhat inter-district boundary (Choudhury 1992).

(c) One seen in the river near Laika Forest Village, Dibru-Saikhowa Wildlife Sanctuary, near the inter-district boundary of Tinsukia and Dibrugarh.

1988: (a) One seen near Tekeliphuta, near Lakhimpur-Jorhat inter-district boundary (Choudhury 1992). It was about 2.5 m long.

(b) One seen basking on the sandy river banks near Kaziranga National Park; it was about 3.5 m long.

1991: (a) One seen in June-July near Bontapu Beat on the river bank in Orang Wildlife Sanctuary, Darrang dist.

(b) One seen in late afternoon in the Siang river between Poba Reserved Forest and Kobo Chapori in the Dhemaji dist.; it was a small specimen, about 1.5 m long. The upper reaches of the Brahmaputra are known as Siang (from near Kobo Chapori in Assam to the Indo-China border in Arunachal Pradesh).

1992: One seen in May-June on the banks near Phansidia Laika-gaon, a Forest Village in Dibru-Saikhowa Wildlife Sanctuary, Tinsukia.

1992-93: Two sightings near Azan Pir's Dargah, Dikhowmukh in Sibsagâr district. One and two specimens sighted respectively.

The gharial has become extremely rare in the Brahmaputra river and its extinction from the entire river system in northeastern India seems to be only a matter of time. The existence of any viable breeding population is unlikely. The main reasons for its decline are:

(1) Heavy year-round use of the river for commercial fishing. The entire river-bed is leased out to *Mahaldars* (contractors) who employ all types of fishing methods including gillnets for commercial fishing.

(2) Encroachment of basking and breeding grounds by humans for setting up fishing camps and for settlement (on the higher banks near the beaches).

(3 Chasing and killing any gharial sighted. There was a case of deliberate poaching between 1982-84 when one gharial was caught in a trap made of many harpoons, in the Brahmaputra river in Tinsukia dist.

(4) Siltation of river-bed due to heavy deforestation at different places.

Although it is difficult to assess the current population size of the gharial in the river, it may be as low as 20 individuals, mostly eastwards of Kaziranga.

No report on breeding could be gathered during the survey. Sighting of young gharials (such as a specimen of about 1.5 m long in the Siang river in 1991) suggests that breeding may still happen in some remote areas of the Siang river in Arunachal Pradesh.

Conservation action for the gharial in the Brahmaputra river should be taken up on a priority basis. Since gharial conservation in other areas, notably Nepal, Uttar Pradesh, Madhya Pradesh and Orissa has been successful to a great extent, there is every reason to assume that the same can be done in Assam and Arunachal Pradesh. Already there are protected areas with potential gharial habitat notably Kaziranga, Dibru-Saikhowa, Orang and Burhachapori in Assam, and D'Ering in Arunachal Pradesh. Release of captive bred gharial into these protected areas must be seriously considered if the species is to survive in the Brahmaputra.

Acknowledgements

For assistance during field survey I would like to thank the following persons, *Lakhimpur district*: Padma Dihingia, Lankeswar Pegu, Biswajit Gagoi, Tankeswar Das Hodura Das, Dharmeswar Pegu, Kula Rajkhowa and Bikul Goswami. *Tinsukia district*: Paniram Das, Nur Hussain, Bolo Pal, Anil Das, Suku Kharia, Koruna Patir, Dulal Pegu, Ranjit Doley, Amal Sahu, Sudhdev Das, Ram Das, Bihuram Mili, Kamal Kalita, Mahadev Rajbongshi, Munin Hazarika, Dilip and Babul. *Sibsagar district*: Prabhat Yien and Baneswar Daring.

March 18, 1997

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18. RECORDS OF TURTLES FROM PAKHUI WILDLIFE SANCTUARY, ARUNACHAL PRADESH, NORTHEAST INDIA.

The northeastern region of India has a high diversity of turtles, comprising at least 17 species (Das 1990). Many species are rare or of indeterminate status. Few locality records exist from Arunachal Pradesh (Das 1995). Four turtle species were recorded during a six month field project (November 1995 to April 1996) in Pakhui Wildlife Sanctuary (WLS) in East and West Kameng districts of Arunachal Pradesh. All the four species recorded are endemic to South Asia (Das 1994).

Pakhui WLS (26° 53.7' N - 27° 16.2' N lat. and 92° 7.5' E - 92° 22' E long.) covers an area of 862 sq. km and the terrain is primarily hilly with elevations ranging from 200 to 1500 m above msl. Pakhui WLS is bordered on the south by the Nameri WLS and reserve forests of Assam. The area is drained by two major rivers, the Bhareli and the Pakke which are distributaries of the Brahmaputra river. The vegetation type is mainly tropical semi-evergreen with several evergreen species as well as deciduous elements. Canes and palms are common in the moister areas near small *nalas* (= minor streams). The sanctuary is located on the north bank of the Brahmaputra. Several perennial hill streams and smaller *nalas* crisscross the area. Tall grassy patches are found along the larger perennial streams such as the Khari and Lalung *nalas* in the Khari area. The sandy banks along these fast-flowing streams are strewn with pebbles and boulders and form a good undisturbed habitat for hardshell and softshell turtles. At many places, rock pools are also formed along cliffs. There is practically no disturbance, except for occasional cane-cutters in winter. All along the length of Khari and Lalung *nalas,* there are sandy banks and boulders. The combined length of these two *nalas,* which originate in the hills and join at Khari from opposite directions, is around 20-30 km. The locals informed me that they found turtle nests and remains of egg shells along the sandy banks. However, I came across turtle tracks along the sandy banks of Khari *nala* only once.

In November 1995, I found a hardshell turtle caught in a bamboo fishing basket which had been set up on Khari *nala* to catch fish. The specimen was small, and was later identified with the help of a colleague, Rashid Raza, as the Assam roofed turtle (*Kachuga sylhetensis* Jerdon 1870). The identification was made on the basis of the prominent keel, the highly serrated posterior marginals and the second vertebral keel being longer than the third vertebral keel. The individual was a juvenile (CL *c.* 9-10 cm).

The Assam roofed turtle is restricted to the evergreen forest tracts of northeastern India, with previous locality records from Assam, Nagaland and Meghalaya (Das 1995). Fast-flowing streams and small rivers in the hills of northeast India forms its habitat (Das 1985, 1991). This species is reportedly rare (Das 1991, Bhupathy *et al.* 1992), and is the least known with the narrowest distributional range (Das 1995). The first record of this species from the north bank of the Brahmaputra river was relatively recent (Das 1990). Later Bhupathy *et al.* (1992) and Choudhury (1993) reported it from Nameri WLS and Ghilamara in Assam respectively. The present record is from Khari *nala* in Pakhui WLS, which is just 100-200 m from the Assam-Arunachal Pradesh border. This extends the distribution further north and is the first record of the species from Arunachal Pradesh.

In subsequent months, I did not find any turtles or evidence thereof along the stream beds. In April 1996, I found four turtles in Khari *nala.* Two individuals were the Indian peacock softshell (*Aspideretes hurum* Gray 1831) (CCL = 9.8 cm, CCW = 9.5 cm, CPL = 10 cm, CPW = 8.5 cm). Both were juveniles, the measurements given above are of the bigger individual (see Appendix 1 for a description).

The Indian peacock softshell turtle is widespread in the northern part of the Indian subcontinent, in the drainage of the Ganga, Brahmaputra and Subarnarekha rivers (Das 1995). It inhabits rivers, ponds and lakes (Das 1985; 1991). This species has been reported by Bhupathy *et al.* (1992) from two localities in eastern Arunachal Pradesh (south bank of the Brahmaputra), all other records being from Assam.

The other two were of the species Asian leaf turtle (*Cyclemys dentata* Gray 1831). The measurements of the two *Cyclemys* are CCL = 9 cm, CCW = 8.8 cm, CPL = 8.6 cm, 7.3 cm, CPW = 7.2 cm, 6.2 cm. Its distribution ranges from northeast India to southeast Asia. This species has been recorded earlier from localities in Assam and Meghalaya (Das 1995) and three localities in Arunachal Pradesh (Bhupathy *et al.* 1992).

In April 1996, Mr. Pratap Singh (DCF Wildlife, Itanagar) and I went to a place called Pukhri (a marshy pond on a hilly plateau in totally undisturbed semi-evergreen forest). The pond is about 50 m wide. We sighted three turtles basking in the sun, on a fallen log at the edge of the water. I could tentatively identify it as the Indian flapshell turtle (*Lissemys punctata* Bonnaterre 1789). We could only approach them to about 15 m and observed them with binoculars. They could not be caught or measured for proper identification. The flapshell occurring in the northeast is a different subspecies and is widespread in the Brahmaputra drainage (Das 1991). It is known to bask on the banks of ponds, on driftwood and floating vegetation (Das 1995).

Pakhui WLS appears to support a highly diverse turtle population, and an intensive survey for turtles should lead to more detailed information regarding nesting seasons, habitat and localities, and further new records. The area is undisturbed and there is practically no exploitation for meat or egg collection. Das (1990) stressed the need for establishing the zoogeographic patterns of many of these species. Bhupathy *et al.* (1992) recorded that in Assam and Arunachal Pradesh there are reports of 19 species of freshwater and land tortoises. *Kachuga sylhetensis* was reported as rare in northeast India, known only from a few specimens and locality records. The Indian peacock softshell turtle and the Asian leaf turtle were reportedly more common. The peacock softshell was recorded in several markets in Upper Assam (Frazier and Das 1994). Barring the Asian leaf turtle, the species recorded are listed in Schedule I of the Wildlife (Protection) Act, 1972.

Besides the two specimens seen in the wild, I came across a peacock softshell and two Assam roofed turtles in an aquarium inside a small roadside restaurant on the Tezpur-Tinsukia highway at Jaklabandha near Bokakhat in April 1996. Two spotted pond turtles (*Geoclemys hamiltonii* Gray 1831) were also kept in the same tank. The owner reportedly bought them for Rs. 120 from a Arunachali, two to three years ago. This species inhabits shallow standing water bodies and is common in Kaziranga National Park which was close to the area. It has been reported from Assam and Meghalaya in northeast India (Das 1995). The species is protected under Schedule I of the Wildlife (Protection) Act, 1972 and in Appendix I of CITES.

I thank the Arunachal Pradesh Forest Department for granting permission for field work and D.N. Singh, DFO of Pakhui WLS for help during field work. I also thank Rashid Raza for help in identifying one of the turtle species.

June 24, 1997

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Appendix 1

COLORATION AND MORPHOLOGICAL CHARACTERISTICS OF TURTLES

Hardshell turtles - two of same species (Asian leaf turtle)

Both individuals had 10 marginals on each side, serration at the posterior marginals starting from 7th till 10th; four on midback, 2 in front, 2 small behind. Hooked jaw, webbed feet, though digits free, five claws on forefeet, carapace flattened.

Bigger specimen - female (flat plastron)

Tail length - 2 cm. Carapace covered with moss and algae and a light cream brown colour with small black radiating lines on each scute.

Smaller specimen - male (concave plastron).

Tail length - 1.8 cm. Carapace brown, plastron, a dark rufous brown colour.

Softshell turtles - two of same species (Peacock softshell turtle)

Two of the same species, both juvenile, though one about twice the size of the smaller one. Aggressive, active, tries to bite, neck extensible, protrudes long neck. Coloration of both same. Four very prominent large eye spots on carapace. Eye spot - black circle surrounded by orange yellow ring, the outer circle around the yellow ring also black. Whole body mottled, blotched pattern of ochre yellow brown rectangular patches, stripes and spots, dark brown to black background. Circular carapace. Plastron greyish. Head with black reticulations and yellow patches. Five claws on digits on the hind feet. Left hindfoot length - 4 cm, left forefoot length - 3.2 cm (larger specimen).

19. FIRST RECORD OF THE SPOTTED FOREST GECKO *GECKOELLA COLLEGALENSIS* (BEDDOME, 1870) FROM GIR FOREST, GUJARAT STATE, INDIA

(*With one text-figure*)

On 8th November, 1996 at 18:05 hrs a brown coloured large spotted gecko was observed under stones, along with another lizard species *Mabuya macularia* and *Hemidactylus brookii*, at Pilhipat area of Gir forest, Sasan, Junagadh dist. On examination it was confirmed to be *Geckoella collegalensis*.

The measurements, colour and scales details are as follows: total body length 7 cm; snout to vent length 4 cm and tail 3 cm. Head moderate, snout larger, eyes large with vertical pupil, ear-opening small, oval. Tail shorter than the head and body length, and swollen at the base. Lateral fold absent. Digits clawed and

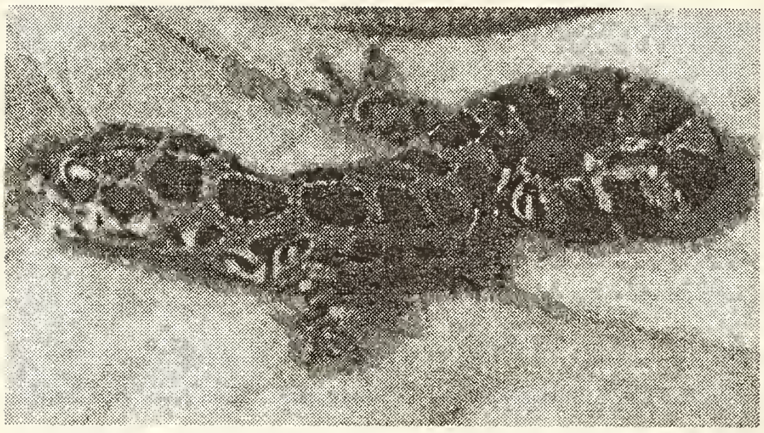

Fig. 1. Spotted forest Gecko *Geckoella collegalensis* from Gir Forest, Sasan

cylindrical, last two distal phalanges compressed and angularly bent. Hind limbs just reach the axilla (BNHS, Regn No. 1434).

Supra labials 12, lower labial 9, posterior labials smaller and granules near the jaw angle. A pair of large postmental scales. Enlarged dorsal tubercle absent, belly with rounded imbricate scales. Tail scales larger than the dorsal and belly scales.

Body colour light grey with large rounded black-edged brown spots from head to tail, in paired row, lateral spots are small. Limbs are dark brown, marbled markings. Lower jaw and throat white with brown dots. Belly white coloured and tail with dark brown bands.

According to Smith (FAUNA OF BRITISH INDIA, 1935-1938, Vol. II) *G. collegalensis* is found on the hills of southern India and Sri Lanka at low elevations, while Sekar (*Hornbill* 1994 No. 4) reported from Sanjay Gandhi National Park, Mumbai, Maharashtra, the range extension of the species, upto the northern end of Western Ghats. The present record, a first report of *G. collegalensis* from Gir Forest, shows further range extension of this species.

September 16, 1997

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20. INANIMATE FEEDING BEHAVIOUR OF TUCKTOO *GECKO GECKO* LINN.

The tucktoo is the largest among geckos and the common house gecko of southeast Asia, found in India only in Bihar, Bengal and Assam (Daniel 1983). This lizard is, however, found in Mizoram in towns like Aizawl, Champhai, Serchhip, Kolasib, Vairangte, Lunglei and Lawngtlai. Mizos believe that the houses which harbour tucktoo, locally called as "ok..ok.." are lucky (Harit and Harit 1966). In Mizoram they are generally found in houses made of bamboo or Assam type houses made of asbestos tiles (Harit 1996). In concrete houses tucktoo is uncomon due to lack of hiding places. The literature on this gecko is meagre. McCann (1940) reported on its colouring, habitat and voice. Whitaker and Whitaker (1979) have described its breeding.

In the month of July 1997 I was discussing lizards with one of my friends. He told me that one midnight he heard a sound like *khat... khat...* many times and when he got up he found that it was a tucktoo, holding one of the many plastic toy fish hanging on the wall of the sitting room, and battering it against the wall. The wall was a plywood partition of the sitting room. The toy fish was nearly 3 cm long and 1.5 cm in width, and all the toys were joined together by a strong thread. On seeing my friend the gecko left the toy fish and went to its hideout. Then he heard some sound from the water heater which he had forgotten to switch off when he went to sleep, as the electricity had gone off. The whole bucket of water had nearly evaporated due to the long time the water heater was inside. The water heater was switched off.

My friend concluded that it was the 'ok' that had saved them, otherwise there would have been an electric short circuit or fire, and hence they were lucky to have 'ok' in their house. Such is the faith of the Mizos.

Lizards are generally found to feed on live and walking insects. Dead insects under experimental conditions are not touched. Cases of ejection of some distasteful insects (?) accidentally hunted and taken into the mouth has been observed in *Hemidactylus flaviviridus* at Kolasib (Mizoram) by me.

The above mentioned incident of the tucktoo trying to feed on an inanimate object indicates that probably the lizard is not able to recognise whether its prey is dead or alive and is possibly stimulated only by the movement of the likely prey. Secondly, the continuous battering of the toy fish also indicates that the lizard was not able to test the taste of the prey.

This type of inanimate feeding behaviour of tucktoo is very peculiar and unusual and hence worthy of record.

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21. NEW LOCALITY OF THE KOYNA TOAD, *BUFO KOYNAYENSIS* (AMPHIBIA)

The Koyna toad, *Bufo koynayensis* (Amphibia) Soman 1963, was described by Soman in 1963 from Humbali village, Shivaji Sagar lake at Koyna, Satara dist., Maharashtra at about 1300 m (Frost, 1985). One more toad species was also described from the same locality as *Bufo koynayensis,* namely *Bufo sulphureus* by Grandison and Daniel (1964). As the morphological features of *Bufo sulphureus* were similar to *Bufo koynayensis,* the former was synonymised with the latter (Dutta, 1992). The distribution of the Koyna toad was known only from the type locality (Frost, 1985).

In August 1995, during a survey of amphibia along the Western Ghats in southern Maharashtra, three adults and some juveniles of *Bufo koynayensis* were collected at the forests of Amboli ghats (15° 52' N, 73° 56' E), at 750 m elevation, in Savantwadi taluka, Sindhudurg dist. Collection data and morphometric details are as follows:

Materials: 3 exp. (2 females, 1 unsexed); BNHS Regn No. 3018, 3019 & 3037; Amboli (alt. 750 m); 25.viii.95 & 26.viii.96; Coll. Aloysius G. Sekar and V.M. Hegde.

Measurements: Snout-vent length of females 31.0-32.0 mm; head length 8.75-9.75 mm; head width 11.05-11.95 mm; tibia length 10.5-11.95 mm; snout-vent length of unsexed specimen 27.6 mm; head length 8.2 mm; head width 10.45 mm; Tibia length 10.3 mm.

The other morphological characters perfectly match the description of *Bufo sulphureus* (Grandison and Daniel, 1964). However, the colouring of the toads in the present collection slightly differs from that of the earlier description. The dorsal surface of the adult was described as yellowish brown and marbled with grey on the flanks, whereas the toadlets were greenish brown on dorsal side and could be distinguished immediately from the blackish brown toadlets of the common toad, *Bufo* *melanostictus*. Both the females were gravid with ripe eggs.

Ecological notes: Two individuals were collected from the short-grass patch in the thick forest during a shower, whereas one specimen was picked up from the wet soil covered with wet leaf litter in the forest. The toadlets of *Bufo koynayensis* were seen hopping around along with the common toad *Bufo melanostictus* on the forest floor. However, the Koyna toad was not sighted with the common toad in any other habitat except the forest habitat, while the common toad was sighted everywhere in the forest as well as around human habitation in the town. The numbers of the Koyna toad were less compared with other amphibian species at the same site. It seems the population of this toad is poor even in the forest habitat.

The Koyna toad, *Bufo koynayensis*, is considered as an endemic species of Maharashtra since its first description in 1963. No information is available on its distribution either within the state or outside it for about 32 years. The recent record of this species from Amboli at the southern border of Maharashtra, on the Western Ghats, indicates that this species may occur in the neighbouring states of Karnataka and Goa also.

I thank Dr. Jay Samant, ex-Director, BNHS, who initiated the survey of South Maharashtra and Mr Vithoba Hegde who accompanied me during the survey. I thank the BNHS for financial support and the forest department, Savantwadi, for their cooperation during my visit in Amboli.

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22. OCCURRENCE OF *RAMANELLA VARIEGATA* (ANURA: MICROHYLIDAE) IN WEST BENGAL WITH NOTES ON ITS DISTRIBUTION IN INDIA

On the evening of 13th April, 1996, a small microhylid frog with yellow blotches on the back was collected from the toilet of the Banspahari Forest Rest House, Banspahari Range, West Midnapore Forest Division, Midnapore District, West Bengal. It was identified as *Ramanella variegata* (Stoliczka, 1872). The specimen, a male with brown spots on the throat and measuring 21 mm from snout to vent was deposited at the National Zoological Collections (Regn No. A8748), Zoological Survey of India, Calcutta. As the species has not been included in the Z.S.I.'s State Fauna Series: Fauna of West Bengal, Amphibia (Sarkar *et al*, 1992) and had not been reported from Midnapore district (Mansukhani and Sarkar, 1977), this specimen constitutes the first record of the species from West Bengal.

The species is known from Tamil Nadu, Kerala, Karnataka, Andhra Pradesh, Madhya Pradesh and Orissa and extralimitally from Sri Lanka. While Daniel (1963) claimed the species to be rare, recorded mainly from eastern peninsular India upto Chanda in Madhya Pradesh, Murthy (1968) who reported it from Madras, claimed it to be common. The species along with two others, *R. montana* (Jerdon, 1854) and *R. triangularis* (Gunther, 1875) was referred to the genus *Callula* till Rao and Ramanna (1925) revised and renamed it under the genus *Ramanella*. Not much is known about the biology of the species. Rao and Ramanna (1925) report that the species is found in *termitaria* or under stones in association with large black scorpions *Heterometrus* sp. They live mostly underground and emerge only after heavy rains when their loud call *ghauy ghauy* can be heard throughout the night. The advertisement call was studied by Kanamadi *et al.* (1993) while its breeding and development was studied by Dutta *et al.* (1991).

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23. *CHAGUNIUS CHAGUNIO* (HAMILTON-BUCHANAN) (PISCES: CYPRINIDAE): A NEW RECORD FROM KUMAON HILLS, UTTAR PRADESH

(*With one text-figure*)

During the course of observation of fishes caught by a fisherman from Kali-Sharda river from Baramdeo (240 m above msl near Tanakpur) a fish was observed, which was later identified as *Chagunius chagunio* (Hamilton-Buchanan). The river stretch where the fish was caught is a transition zone where the mountainous river (Kali) reaches the plains; further downstream, the river is known as Sharda. The river is very deep and moderately rapid at this zone and the substratum consists of rocks and sand.

The above mentioned fish was caught along with *Tor putitora* and *Labeo dero* on July 29, 1997 from the flooded river with the help of a locally fabricated gill net. *C. chagunio* has not been reported from Kumaon hills in earlier studies (Hora 1937, Menon 1949 and Pant 1970).

Chagunius chagunio Hamilton-Buchanan

Weight 217.0 g., Total length 27.5 cm., Standard length 22.5 cm., Head length 5.5 cm., Body depth 6.0 cm.
Local name: Musaina, Dhuiyan.

Diagnostic features: D. I 8; P iii 12; V ii 8; A ii 6; C. 22; L. 1 46

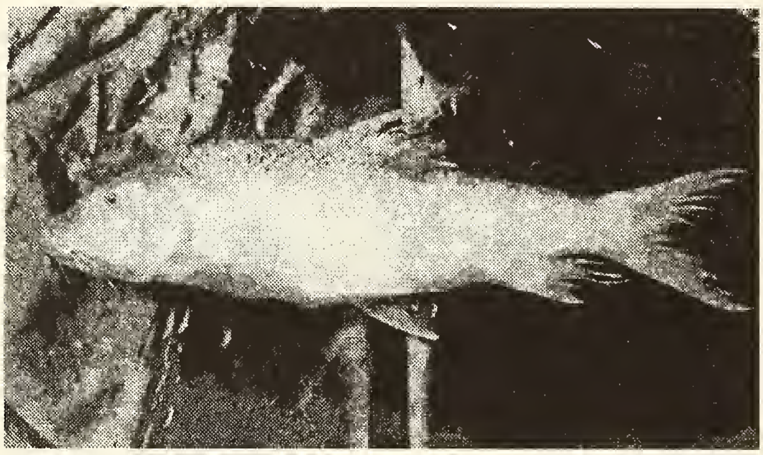

Fig. 1. *Chagunius chagunio* (Hamilton-Buchanan), male

Length of head 5 cm, height of body 4.5 cm in total length. Body elongate, its depth is more than its head length. Mouth narrow and subterminal, barbels 2 pairs, longer than orbit. Suborbital region, cheeks and anterior superior margin of the orbit is covered with numerous pores. Dorsal spine osseous, strong and recurved, its length is rather more than that of head, excluding the mouth. Dorsal fin commences midway between the end of the snout and the base of caudal fin. Scales small; lateral line complete; lateral line scales 46; 6 scale rows between lateral line and pelvic fin; 15 rows before the dorsal fin. The specimen is identified as male, because of the pronounced tubercles on snout and cheek, and elongated last two anal fin rays extending to base of caudal fin.

Colour: Silvery with a pinkish tinge; black at scale margin. Fins reddish with light outer rays.

The occurrence of *C. chagunio* in this lotic water extends its distributional range upto the foothills of Kumaon Himalaya. In earlier studies, the distribution of the species was recorded from Orissa, throughout Bengal, Bihar and NW Province to the Punjab (Day 1878-88), Brahmaputra and Ganga drainages along the Himalayan foothills (Talwar and Jhingran, 1991).

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24. NEW RECORD OF *PUNTIUS MELANAMPYX* (CYPRINIFORMES: CYPRINIDAE) AND *MICROPHIS CUNCALUS* (SYNGNATHOFORMES: SYNGNATHIDAE) FROM KARNATAKA, INDIA

During a recent survey of fishes from the Western Ghats region of Northern Karnataka, a few specimens of *Puntius melanampyx* were collected from a stream near Kadra (a tributary of Kali river, near dam site) and six specimens of *Microphis cuncalus* were also collected downstream from Aghanasini river. Literature and reports on fishes of Karnataka (Day 1878-88, Talwar and Jhingran 1991, Jayaram in press) show that this species was not known from this region.

Puntius melanampyx

This species was collected in June 1996 from a stream near Kadra dam site, a tributary of the Kali river *P. melanampyx* was originally described by Day (1865). It is a widely distributed species recorded from the Wynaad, Nilgiri and Travancore ranges of hills, and streams and the Cauvery river. Later, Hora and Law (1941) reported it from Pampadampara and Silas (1951) recorded it in Vannamudi Bridge, Anamalai Hills, Ponnai, Nelliamputhi Hills, Periyar drainage from Kerala. This species is being recorded for the first time from Uttar Karnataka Western Ghats region.

Description: D ii 8, P 14, C 20, LL 19-20, Pre.D.Sc 7. Head length 3.1 to 3.4 times in standard length. Eye diameter 2.6 times in head length. Body depth 2.5 times in standard length. *Colour*: In live fish, light golden brown with three dark black vertical bands on the flank. After preservation, dull brown, the vertical bands faded.

Microphis cuncalus

This species was collected in June 1996 downstream of Aghanasini river near Kritikada village. Its occurrence from this area extends the distribution range of the species to the Western Ghats of Karnataka. In earlier studies the species was recorded in estuaries of northern Calcutta (Hamilton 1822), brackish water of Bombay (Klausewitz 1955), Dhaleswari river, northern Munshigany, Bangladesh (Rahman 1976).

Geographical distribution in India

This species inhabits rivers ascending far above the tidal influence, estuaries and the low salinity habitats of West Bengal, Orissa, Maharashtra, Goa, Kerala and Tamil Nadu. For the first time, we recorded this species from the stream habitats of Karnataka. Water quality parameters, such as dissolved oxygen (12 mg/1), alkalinity (30 mg/1), total hardness (26 mg/1), total dissolved solids (63.7 mg/1) and conductivity (0.047 m mhos) were recorded. The water quality parameters show that it is a purely freshwater (stream) habitat.

Description: D 43-44, Rings (15+17) + (27-28), P 18-19, C 8-9. Head length 6.8 to 7.8 times in standard length. Body depth 3.4 to 4 times Head length. Eyes of moderate size situated at mid-length of head. *Colour*: Preserved specimens dusky green dorsal side, ventral side dull white and caudal fin dark brown.

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25. *HYPSELOBARBUS KOLUS* (SYKES) - AN ADDITION TO KERALA

TABLE 1
MORPHOMETRIC AND MERISTIC MEASUREMENTS OF *HYPSELOBARBUS KOLUS* FROM KERALA

D=4/9; P=1/14; V=1/8; A=3/5; Lr.=42.

Character	Range	Mean
Total length	124.32 - 134.45	—
Head length	26.65 - 29.19	27.76
Eye diameter	6.59 - 7.28	6.81
Snout length	11.54 - 11.89	11.72
Inter-orbital width	10.44 - 11.42	10.95
Body depth at dorsal origin	26.29 - 28.43	27.30
Body depth at anal origin	16.49 - 18.27	17.51
Pre-dorsal length	47.02 - 52.29	50.06
Pre-pectoral length	25.38 - 29.14	23.41
Pre-ventral length	47.03 - 51.92	26.85
Pre-anal length	74.59 - 80.77	77.94
Length of dorsal	24.87 - 26.29	25.46
Length of ventral	18.78 - 19.78	19.29
Length of anal	19.54 - 24.86	21.18
Length of pectoral	20.00 - 20.81	20.26
Length of caudal peduncle	12.97 - 15.23	14.06
Width of caudal peduncle	11.43 - 12.18	11.76

The large scaled barbels of the genus *Hypselobarbus* are distributed in Peninsular India. Six species have so far been described (Talwar and Jhingran, 1991). Recently, Menon and Rema Devi (1995) added *H. kurali* from southern Western Ghats. While describing this new species, they considered *H. kolus* as a synonym of *H. curmuca* without any discussion. However, Talwar and Jhingran (1991) treated *H. kolus* as a valid species and described its ranges as Krishna, Godavari and Cauvery river systems.

A recent survey in different systems of northern Kerala revealed the absence of *H. kolus* and *H. curmuca* in the east-flowing river systems (tributaries of Cauvery) whereas *H. curmuca* was present in the west-flowing rivers (Shaji *et al.*, 1995; Easa and Basha, 1996). In the southern parts of Kerala, both *H. curmuca* and *H. kurali* are present (Shaji and Easa, in press). During a recent visit to Parambikulam Wildlife Sanctuary in Palghat dist., Kerala, two juveniles of the species were collected from the Thunacadavu reservoir. Four adult specimens (17.85-19.70 cm SL) were also obtained from a local fisherman residing near Chalakudy river at Malakkapara. This is the first record of *H. kolus* from Kerala.

The morphometric and meristic measurements are given in Table 1.

The species shares some characters such as the number of lateral line scales and the weak last unbranched ray of the dorsal fin, with *H. curmuca* and *H. kurali.* But the presence of only two barbels makes *H. kolus* distinct from the two. There is a notable difference between the species in colour. In *H. kolus,* the flanks are silvery with a faint slate colour. Dorsum is slightly blackish and ventral part dirty white. All the paired and median fins are blackish at their bases and tipped with orange.

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26. ON THE OCCURRENCE OF TWO FLYING FISH: *PROGNICHTHYS GIBBIFRONS* (VAL.) AND *EXOCOETUS VOLITANS* LINN. (PISCES: EXOCOETIDAE) IN WEST BENGAL

The marine Ichthyofauna of West Bengal has been described by Talwar *et al.* (1994), and Chatterjee *et al.* (in press). In their accounts there is no mention of the blunt-nosed flying fish *Prognichthys gibbifrons* (Val.) and two-winged flying fish *Exocoetus volitans* Linn., family Exocoetidae from West Bengal, which are known from India as well as tropical and subtropical seas. Recently, the authors came across two specimens, one each of *P. gibbifrons* and *E. volitans* of total lengths 195 mm and 147 mm respectively, caught with drag nets by fishermen of Digha from Bay of Bengal on 22.12.92 and 12.3.96 respectively. The description of both species is given below.

Prognichthys gibbifrons (Val.)

Material Examined: 1 ex. locality: Digha Hospital Ghat, Coll. S. Talukdar & P.N. Jana, MARC. Regn No. 669, dt. 22.xii.92.

Diagnostic Characters: D. 12, P. 16, V.5, A.9, C. 10/12, Predorsal scales 24. Body oblong, gill openings wide, jaws short, pectoral fins elongated, reaching beyond the end of dorsal. First two pectoral rays unbranched. Origin of anal opposite 4th dorsal ray. Ventrals much longer than the head, originating about midway between caudal and eye. Eyes very large, snout blunt when mouth is closed.

Colour: Brown above, white below, dorsal and caudal brown. Pectoral gray with lighter middle region. Ventral with darker rays in middle.

Exocoetus volitans Linnaeus.

Material Examined: 1 ex., locality: Digha Hospital Ghat, Coll. J. Sarkar, MARC. Regn No. 1665 dt. 12.iii.96.

Diagnostic Characters: D-14, P. 14, V.6, A. 13, C 7/9. Body moderately oblong. Gill openings very wide, Jaws short, the premaxillaries and maxillaries separate. Pectoral fins elongated, and reaching caudal base. Ventrals small, originating nearer tip of snout than caudal base. Eyes large. Snout obtuse when the mouth is closed. 6.5 rows of scales between the origin of the dorsal fin and the lateral line.

Colour: Bluish along the back, becoming lighter on the sides and beneath. Pectorals greyish.

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27. SEXUAL DIMORPHISM OF A PERCH *PRIACANTHUS HAMRUR* (CUV. & VAL.)

(*With four text-figures*)

The present work deals with the sexual dimorphism of *Priacanthus hamrur* (Cuv. & Val), an edible perch. Thobias (1974) drew attention to the sexual dimorphism of a barb, *Puntius filamentosus* (Val.) while Inasu (1993) worked that out for a freshwater puffer fish *Tetraodon travancoricus* Hora & Nair. Day (1958) described the genus *Priacanthus* based on a single species (*P. blochi*). Four species of *Priacanthus* were subsequently described by W. Fischer (1974). Sexual dimorphism has not been studied in any of these species.

About 27 adult specimens of *Priacanthus hamrur* (Cuv. & Val.) were collected in February - March 1997 in fresh condition from Munampam (Trichur dist. Kerala). Total length,

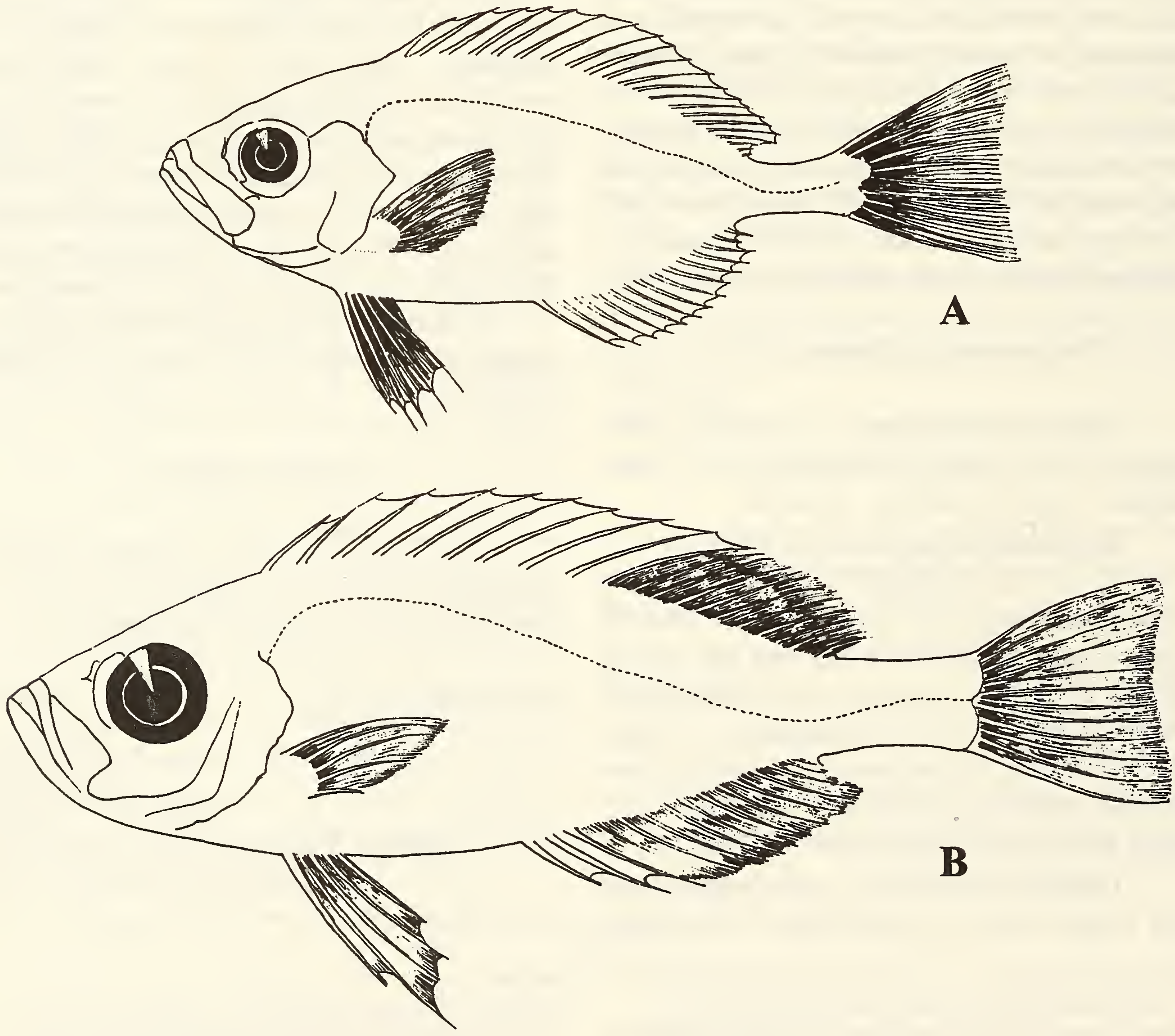

Fig. 1. *Priacanthus hamrur* (Cuv. & Val.) A: Male; B: Female

head length, caudal peduncle length, maximum width, inter-orbital diameter and total weight of each specimen were recorded separately. The fine morphological differences between males and females, ascertained by dissection, were compared.

A clear sexual dimorphism is present in *Priacanthus hamrur* (Cuv. & Val.). Females are more than twice as large and heavy as the males of the same age group. Lateral line in male is curved downwards in front in the shape of a hook, while it is less so in female. Opercular spine is more sharply marked in males. The dorsal anterior profile of the head in female has a greater downward slope. The soft rays in the posterior half of the dorsal fin of the female are more filamentous and they protrude out from the upper margin of the fin. Inter-orbital diameter is wider in female.

A clear sexual dimorphism was observed in *Priacanthus hamrur* (Cuv. & Val.). Females are much larger and heavier than males. Clear morphological differences also distinguish males from females.

The lateral line is arched downwards at the front end of the body in males. This hook-like downward bend of the lateral line is not so conspicuous in females. The lateral line in female is less arched in front. (Fig. 1A & B).

The soft rays in the posterior half of the dorsal fin are more filamentous and protrude beyond the upper margin of the fin in females, while those in the male are less filamentous and do not protrude so (Fig. 2A & B).

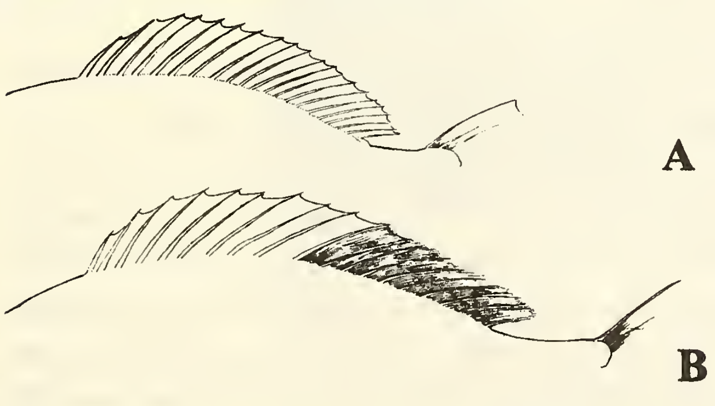

Fig. 2. Soft rays in the posterior half of dorsal fin
A: Male; B: Female

The dorsal anterior profile of the head has a downward slope in female, which is absent in male (Fig. 3A & B).

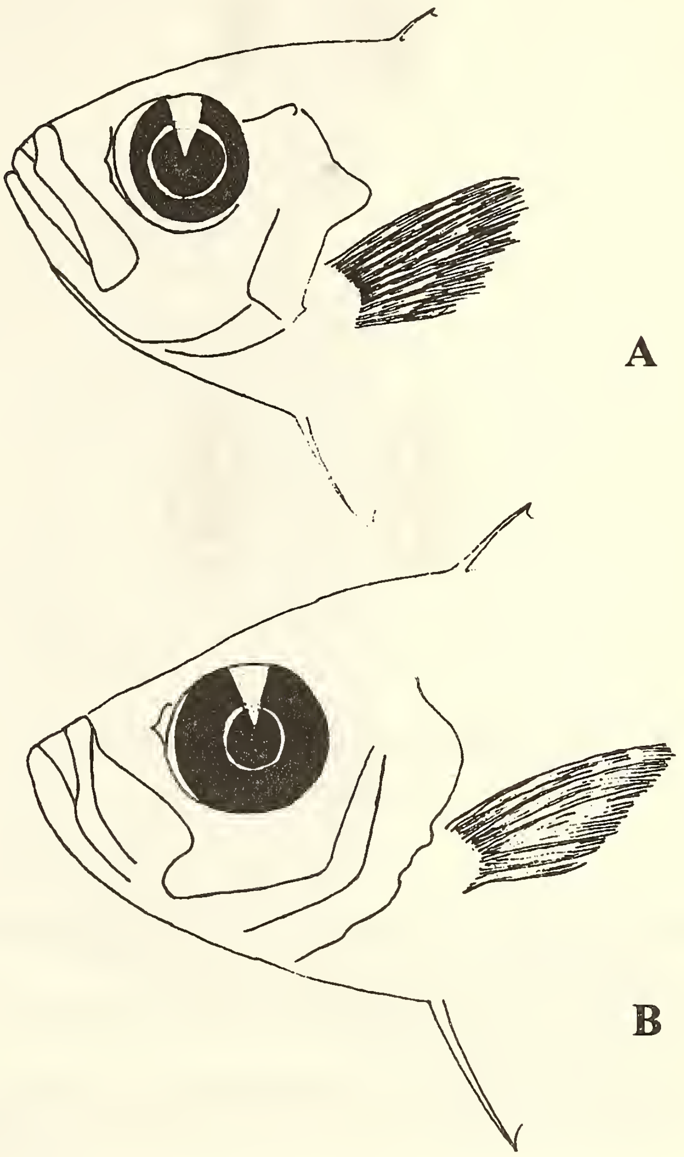

Fig 3. The dorsal anterior profile of head.
A: Male; B: Female

The opercular spine is sharply marked in males, but it is feeble in females (Fig. 3A & B).

The inter-orbital space is wide in females (1.76 cm), but it is less wide in males (1.28 cm). (Fig. 4A & B).

The average body weight of the female is more than twice that of the males of the same age group. Females also dominate the males in all other body measurement as shown in Table 1.

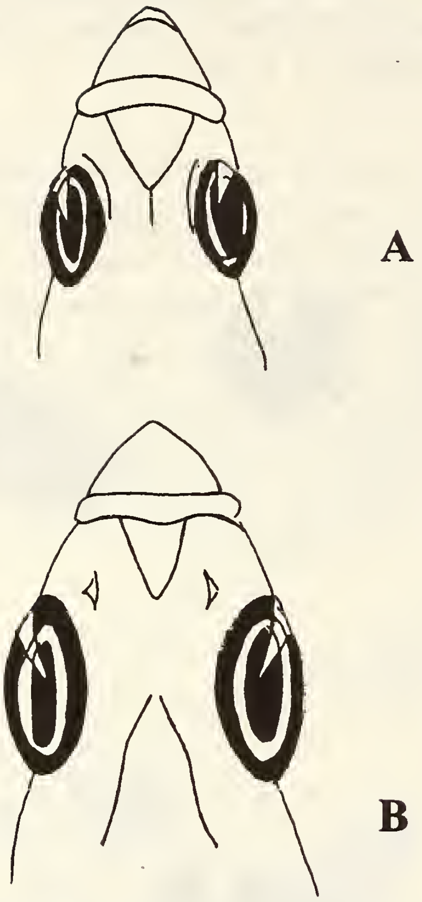

Fig. 4. Inter-orbital space in A: Male;
B: Female compared

TABLE 1
COMPARISON OF MORPHOMETRY IN MALES AND FEMALES OF *PRIACANTHUS HAMRUR* CUV. & VAL.

	Male	Female
1.	Ave. total length 20.57 cm	Ave. total length 26.3 cm
2.	Ave. head length 5.1 cm	Ave. head length 6.13 cm
3.	Ave. caudal peduncle length 2.26 cm	Ave. caudal peduncle length 7.71 cm
4.	Ave. max. width 5.67 cm	Ave. max. width 7.26 cm
5.	Ave. total wt. 101.07 gm	Ave. total wt. 215.8 gm

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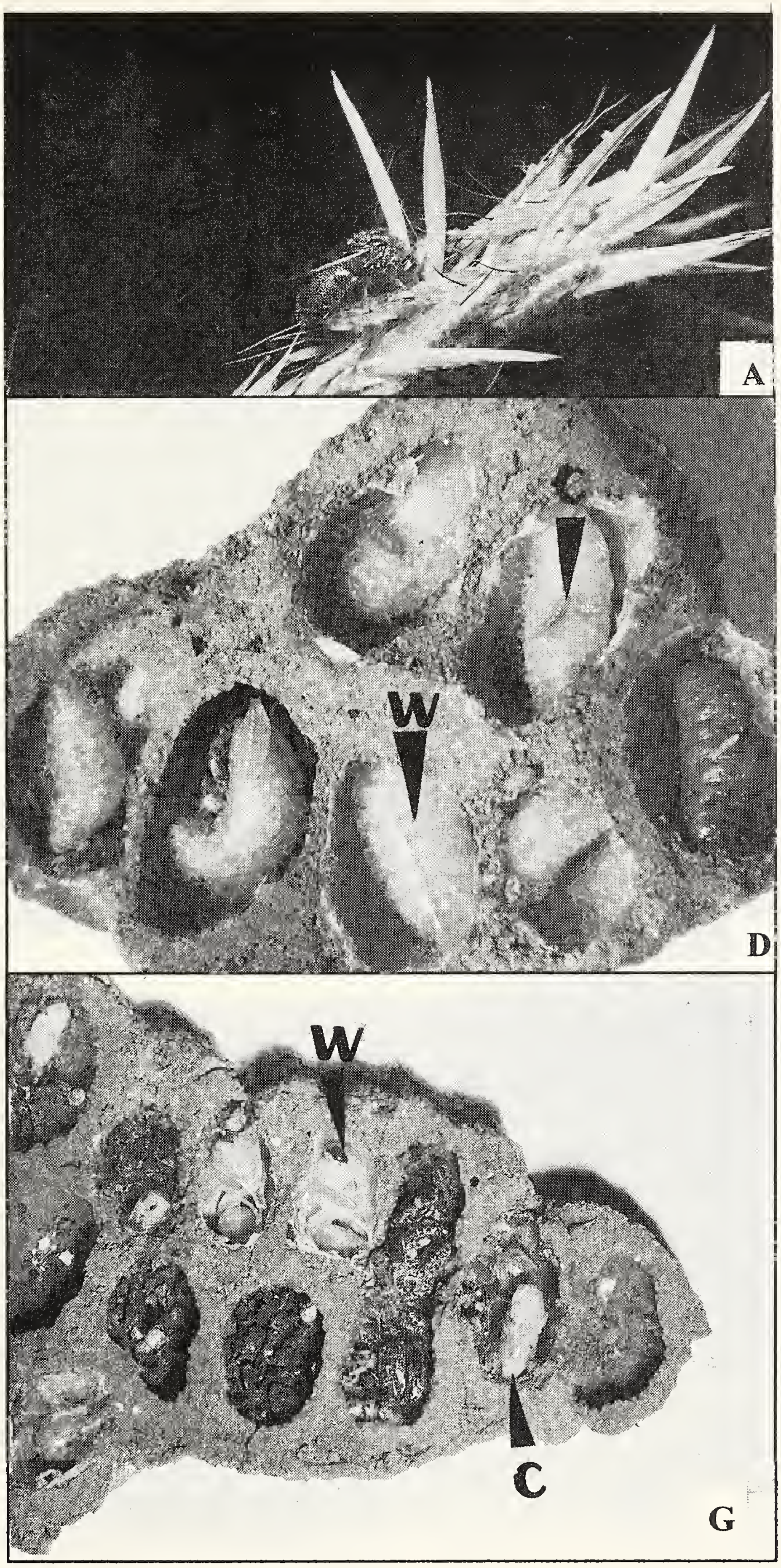
28. BIOLOGY OF THE PARASITIC WASP *STILBUM CYANURUM* VAR. *SPLENDEUS* FABR. (CHRYSIDIDAE: HYMENOPTERA)

(*With one plate*)

The chrysidid wasps *Stilbum cyanurum* var. *splendeus* Fabr. are metallic greenish blue in colour, seen during bright sunshine, and are parasitoids on mud-dauber wasp grubs of the families Eumenidae and Sphecidae. These chrysidid females bore holes on the mud-dauber nest surface into the cells with their long ovipositor and deposit an egg in each cell. After hatching, the chrysidid larva feeds on the well developed wasp grub and pupates at one end of the host cell. The adult chrysidid emerges by gnawing holes at the sides of the cell.

The chrysidid wasps *Stilbum cyanurum* var. *splendeus* Fabr. are solitary or found in groups on vegetation (Pl. 1A). They are always seen hovering over areas where mud-dauber wasps of the family Eumenidae and Sphecidae, especially the mud cell builders such as *Eumenes conica* Fabr., *E. edwardsii* Sauss., *Sceliphron madraspatanam* Fabr., S. *intrudens* Smith., build



A: The female adult chrysidid resting on *Panicum* sp. grass during night;
D: The parasitoid chrysidid grub feeding on the Eumenid grubs in several cells of a nest. C-small chrysidid grub w-wasp grub; G: Eumenid wasp cell nest showing both the chrysidid pupa and the wasp pupa. W - Wasp pupa, C - Chrysidid pupa

their mud nests (Iwata, 1976). Eggs are laid mostly from 1000 hrs to 1700 hrs in the evening, till bright sunshine disappears. The chrysidid females can be seen following the host wasp at a few metres from the nesting site, particularly while the chrysidid females are ovipositing on the host nest. At times the host eumenid or sphecid females return to the nest but the chrysidids are not deterred. Instead they chase the host wasp by fluttering their wings and charging against them ferociously. It is interesting to note that the sphecids immediately respond by defending their cells by placing additional mud pellets over the cell surface, whereas eumenid females fly away and they place the additional load of mud only after the chrysidid wasp departs from the nesting site.

Once the chrysidid female finds a host mud-dauber nest it first examines the surface area for a few minutes. Then, with the help of its salivary secretions it wets the spot for oviposition and starts scratching the spot with the help of its mandibles, continuing for a few minutes. It then ejects its long protruding telescopic needle-like ovipositor and inserts it into the scraped wet spot and revolves it around. If the wasp finds it too difficult to bore a hole, the ovipositor is withdrawn into the abdominal segment. Then again it wets the same spot with its salivary secretions for the second time, scratches with its mandibles, ejects its ovipositor and inserts it into the oviposition site and starts boring the hole again as before. The same behavioural patterns have been observed in *Chrysis fuscipennis* on *Sceliphron* nest (Iwata, 1976). The action of wetting the spot and boring into it with the ovipositor while clinging to the nest surface may be repeated 2 or 3 times to make the hole. The time taken to bore a single hole is between 12 - 15 minutes as the wasp gives a hard second layer of mud brought from a nearby termitarium. In the case of nests of sphecid wasps of *Sceliphron* sp., the time to bore the hole is less when compared to eumenids, as *Sceliphron* sp. takes wet mud directly from ground surfaces or watered pots in the gardens. In certain instances it can be seen that on a few nests a second coating of mud is not given and in such cases the chrysidid oviposition holes are clearly visible as minute holes on the surface of the cell.

When the oviposition hole is complete the chrysidid inserts the ovipositor and deposits a single small white egg into the cell. The egg hatches in 2 to 3 days. In most cases the egg deposited may be at a time when the host wasp cell contains the well grown grub (Fig. D), pupae or preadult so that the parasitoid grub can complete its life-cycle well provisioned. However, in certain instances the egg is oviposited at a time when the host wasp is in the egg stage. In these instances the parasitoid chrysidid undergoes a delay in development until the host grub has grown to a good size (Askew, 1971). In other cases, in a few cells if the host grub has been attacked halfway during the larval stage and the full grown host grub is sufficient at that time for the chrysidid grub, then the cadavers of spiders or caterpillars provisioned will be pushed to one end of the cell and the cocoon formation of the chrysidid grub will take place at the other end (Fig. G). The cocoon is knitted from thin fibres formed by the salivary secretions of the chrysidid grub. These fibres are initially white, turning dark brown or yellow in a few days.

During the present study the egg hatching period was between 2 to 3 days. Larval period was 10 - 12 days. Pupal period was 8 -12 days. Adult emergence took 2 to 5 days. In a period of 30 to 35 days the adult parasitoid wasp gnawed an emergence hole on the host cell wall and escaped.

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29. ON AN UNUSUAL *ENDOCLYTA* (LEPIDOPTERA: HEPIALIDAE) FROM KUMAON, IN THE NORTHWEST HIMALAYA, INDIA

Kumaon lies to the west of Nepal, comprising a section of the Himalayan range bordered by the Tibetan plateau to the north and the Gangetic plain to the south. Insect fauna, at least in the lower hills, consists of Indo-Malayan as well as Palaearctic elements. Recently, an influx of Indo-Malayan fauna has been noted, so that at least among Hawkmoths, this group predominates at present (Smetacek 1994).

Hitherto, only two species of Hepialids, i.e. *Palpifer sexnotatus* Moore and *Hepialiscus nepalensis* Walker, were known from the Himalaya west of Nepal. Both these species have been recorded recently from Kumaon.

On June 25, 1996, a female of the genus *Endoclyta* Felder was attracted to a mercury vapour lamp at Jones Estate near Bhimtal, in Nainital dist. The moth appeared at around 10 pm which is unusual, since Barlow (1982) observes that the moths of this family are active for a limited period of 15 to 20 minutes at dusk and are seldom encountered late at night.

Unfortunately, there does not seem to be a modern revision of the genus *Endoclyta,* and Barlow points out that his placement of the species is tentative. As a result, the specimen under consideration cannot be placed with certainty.

Barlow (1982) illustrated a male of *Endoclyta* (= *Endoclita*) *chalybeatus* Moore, with which the specimen under consideration agrees in the lack of any white marks on the forewing and the termination of the dark discal area on the forewing along vein 2.

It differs in (i) the much darker ground colour of the forewing and the fuscous head, thorax, abdomen and hindwing, which are pale brown in the illustrated male. This may, however, be explained by the fact that the specimen is a female, which is known to be darker (Hampson 1892). (ii) On the forewing, which measures 45 mm, the pale area in the cell is reduced, the pale discal band does not reach the costa and there is no defined pale sub-apical or sub-marginal area. The pale discal band is outwardly sharply defined by an inwardly pale and outwardly dark fascia. The area beyond this is crossed by numerous discontinuous striae. The most prominent of these striae are those bounding the sub-terminal band, which are also inwardly pale and outwardly dark. The band begins above vein 2, proceeding upward in two discontinuous steps to vein 4. From vein 4 to vein 8 the outer fascia is continuous but irregular, while the inner fascia is discontinuous throughout its length. Above vein 9, the band and bordering fasciae lose their prominence among several striae.

Hampson has treated *Endoclyta chalybeatus* as a synonym of "*Phassus signifer* Walker" which, according to him, may be distinguished chiefly by the darker discal markings of the forewing terminating along vein 2. *P. signifer*, however, has white marks in the forewing cell. He mentions an unusual specimen from Burma (Myanmar) in which the ground colour of the forewing is pale brownish yellow, with no white spots in the cell. This unusual specimen is what subsequent workers have treated as *E. chalybeatus*.

There does not appear to be any Indian member of *Endoclyta* combining the characteristic termination of the dark area along vein 2 and the lack of white spots on the forewing. On the basis of the above, I have placed the specimen under consideration as *Endoclyta chalybeatus,* although this is a tentative placement.

The range of *Endoclyta chalybeatus* is Burma (=Myanmar) Thailand and Malaya according to Barlow, and that of "*Phassus signifer*" is Sylhet (Bangladesh), Burma and Borneo according to Hampson.

In any event, the appearance of a female in good condition belonging to this species or a very closely related one over one thousand kilometres west of its known habitat is worthy of note. Barlow gives *Erythrina* as one of the larval host plants of *E. chalybeatus.* Two species of *Erythrina* occur in Jones Estate, i.e. *E. suberosa* Roxb. or the Coral Tree and *E. arborescens* Roxb. Therefore, if the specimen is *chalybeatus* after all, its appearance is perhaps not surprising, given the increasing influx of Indo-Malayan moth species in the Kumaon Himalaya.

August 28, 1997

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30. SIGHTING OF THE COMMON PALMFLY (NYMPHALIDAE: LEPIDOPTERA) IN MUMBAI

On 23 October, 1996 at around 0915 hrs, a common palmfly, *Elymnias hypermnestra caudata* was spotted flying low in the garden of Colaba woods, South Mumbai. The specimen was bright and its striking colour pattern with brownish-black forewings, with a prominent, single white band and rust orange hindwings was unmistakable. Recently, this garden acquired additional palm saplings of *Areca* sp. from Mangalore and it is quite possible that one of them carried the eggs and pupa of this species. It may be noted that Mumbai had inclement weather due to the cyclonic conditions prevailing on the west coast of India during that period.

Mr. Naresh Chaturvedi, Curator of the BNHS, confirmed the species and recommended that this sighting be recorded, as the common palmfly is rarely seen in Mumbai and the surrounding areas. The last sighting was in Kihim across on the mainland in September 1972 (Salman Abdulali *JBNHS* 70: 228).

Subsequently, four more specimens were sighted in Alibag on 7th and 8th June 1997.

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31. THE PLAIN PUFFIN *APPIAS INDRA* SWINHOE: BEHAVIOUR, LIFE-HISTORY AND DISTRIBUTION

(*With one plate*)

The Plain Puffin (*Appias indra* Swinhoe, Pieridae: Lepidoptera) is a medium-sized black and white butterfly. Its distribution covers Sri Lanka, Western Ghats, Nepal, NE. India and

Myanmar southwards, covering most of SE. Asia, mainly around the subtropical evergreen forest zone (Wynter-Blyth 1956, Larsen 1987). It is generally considered to be rare. Wynter-Blyth (1956) gives its distribution in south India from Coorg to Travancore. There are a few records of this butterfly from Maharashtra, and in Pune there are recent records of breeding of the Plain Puffin.

I have personally sighted it in Maharashtra only from Bheemashankar. The Plain Puffin flies mostly in the canopy, occasionally descending to feed on flowers of *Leea* and *Adelocurrium* and more rarely to bask. At Bheemashankar, there would always be one or two Plain Puffins mudpuddling in the forest stream. In the late afternoon, from 3 to 5 pm, a group of 3 to 10 Puffins would be seen in the mud, sitting still with their forewings drawn into the hindwings (a habit of most *Appias* sp.).

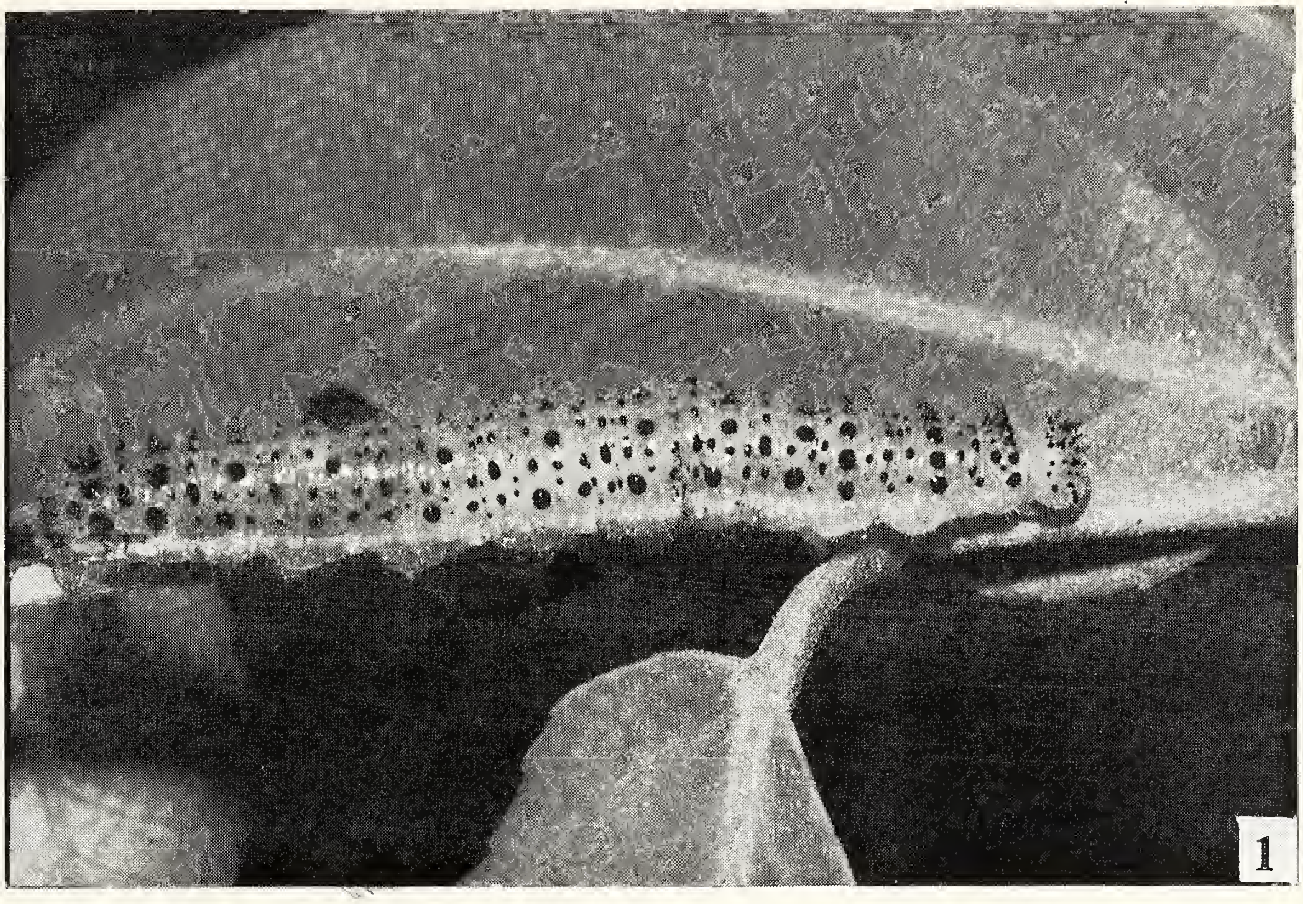
The natural history of the Plain Puffin is poorly recorded. Neither Wynter-Blyth nor anybody else, as far as I know, has recorded its larval foodplant in the wild and other breeding habits. Interestingly, four years ago this forest dwelling butterfly was found breeding on *Putranjiva roxburghii* Wall (family Euphorbiaceae) in the environs of Pune city. A single larva was successfully reared by Mr. Shonil Bhagwat. A few caterpillars were discovered in January 1993 on the same plant. But the imagines were never seen. For next two years, there was no record of adult butterflies, but in mid-September, 1996, came the burst of Plain Puffins. The butterflies were seen feeding on the flowers of *Melia* sp. in a school compound. On searching, some 50 caterpillars of various instars were found feeding on the tender leaves of Putranjiva plants.

Life cycle: The eggs are laid on the underside of tender leaves in batches of 4 to 8. The egg is yellow, typical of a pierid, bottle-shaped and ribbed on the sides.

Larva: The little caterpillar, just after hatching out, is quite difficult to locate due to its extremely small size and pale yellow colour, which matches the mid-rib and veins on the leaf perfectly. It remains pale yellow till it grows upto 4 mm or so in length. Then it begins to develop a remarkably beautiful, rich cerulean-blue coat with black conical projections. It is lemon-yellow on the underside and a similar yellow line runs on each side along the length of the body. The head is yellow. The caterpillar refuses to eat mature leaves, and feeds on young leaves, petioles and even the shoots which bear them. It rests on the underside of young or old leaves, branches etc. without any effort at concealment, though the bright colours make it conspicuous. The caterpillar attains its full length, around 3.5 cm., in about 17 ± 4 days. The body-band is very thin and tightly spun around the caterpillar. The caterpillar is arguably among the finest and most handsome ones from our region.

Pupa: The pupa is found on the underside of the host leaf and is unusual in colour: the ground colour varies from lemon yellow to shades of greenish yellow, with small black dots on it. A long, pointed projection, which is generally upturned at the tip, is present before the head. On the back of the thorax are three flat projections on each side, making a broad flat area on the thorax. Their tips are commonly curved downwards. The pupal period varies from 6 to 9 days.

Parasites: Out of the 20 caterpillars I collected, 2 were parasitized by a wasp belonging to family Chalcidae. Generally, the parasites on butterfly caterpillars are minute in size, but this one was 6 mm long. On pupation, the infected pupa turned dark yellow within 3 days. The parasite could be seen as active within the puparium. The parasite larva pupated inside the dead puffin pupa, without making a cocoon, commencing 3-4 days after the Puffin pupation began. The host pupa was completely devoured except for the eyes, and the parasite pupa could be seen in the thoracic region of the Puffin puparium. After 11 days, that is 6 days after the butterflies from healthy pupae had emerged, the chalcid wasps emerged through the thorax of the



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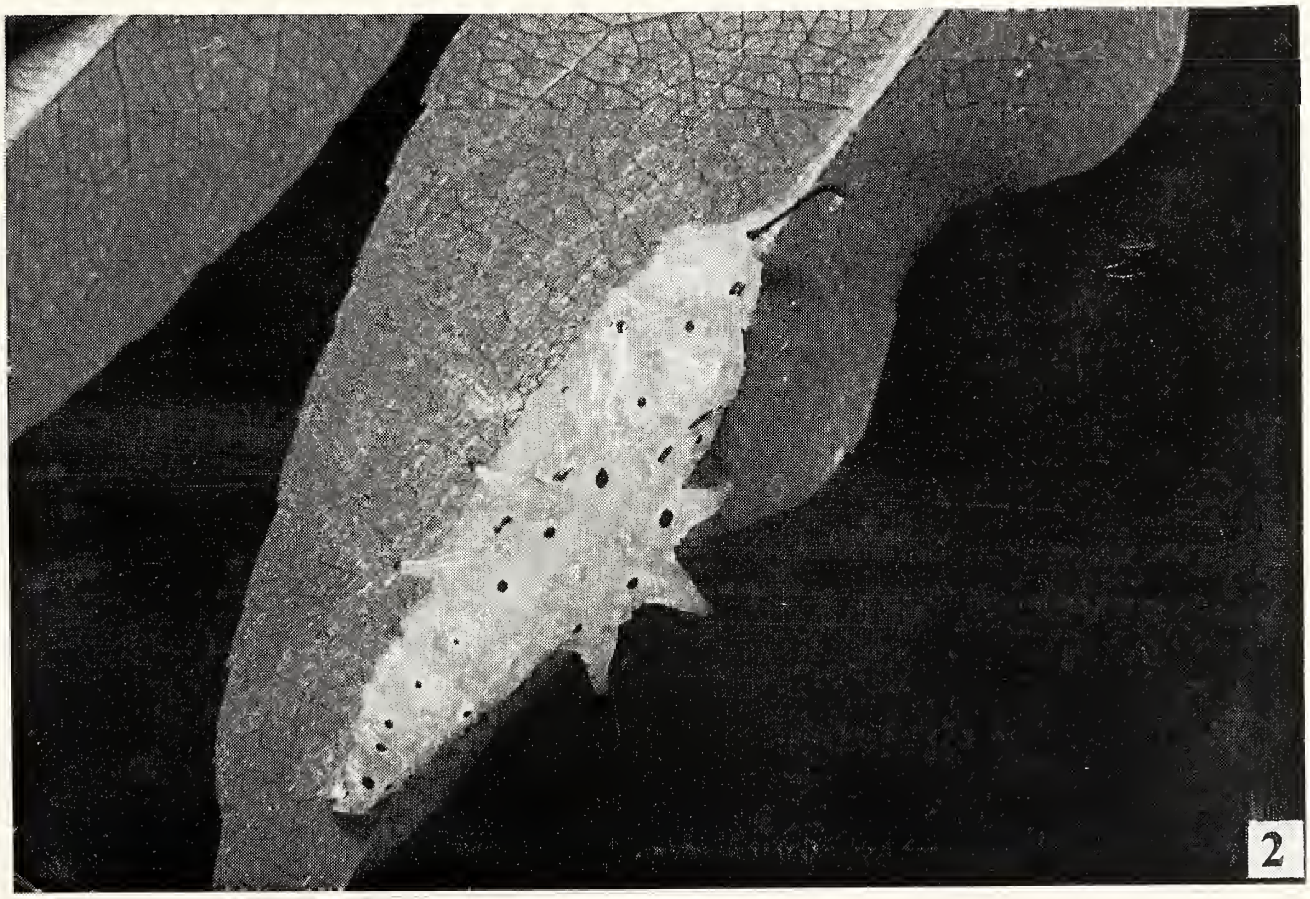

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1. Caterpillar; 2. Pupa of Plain Puffin (*Appias indira*)

dead host pupae by making a round exit-hole 3 mm in diameter. The pressure of the chalcid parasites on the Plain Puffin caterpillar population seems to be high. Out of about 40 pupae investigated in the field, 8 were parasitized by the chalcid wasps, i.e. approximately 20%. Some caterpillars were found to be attacked and killed by unidentifiable microbes and still more by the wandering larvae of unidentified lacewing flies (order Neuroptera).

Out of 18 butterflies that emerged successfully almost half (8) were females and this proportion was also seen in the free-ranging imagines recorded.

The butterfly is consistently present, perhaps in growing numbers, and is breeding here since the last four years. Given the abundant foodplant (*Putranjiva* has been planted as a roadside avenue plant at many places) and temperate climate, it may not be very hard for the Plain Puffin to establish itself in the city.

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32. COMMON SILVERLINE CATERPILLAR FEEDING ON *CADABA INDICA*

The Common Silverline (*Spindasis vulcanus* Fabricius: Lycaenidae: Lepidoptera) larvae have been recorded feeding on various species of plants belonging to families Rubiaceae, Rhamnaceae and Verbenaceae. Their choice of larval foodplant does not seem to depend much on the plant itself, but on the presence of attending ants, so the butterfly has managed to breed on species of diverse plant families.

Dr. Makarand Dabak found a caterpillar of a Lycaenid in a small cell made of a few *Cadaba* sp. (Capparidaceae) leaves, constantly attended by small black ants. I reared it at home and the caterpillar fed happily on the leaves of *Cadaba.* After it was full grown it went into pupation and formed a jet black pupa. The Common Silverline emerged out of the pupa.

No Lycaenid has been recorded as feeding on plants of Capparidaceae, which are common foodplants of many of the Pierids. The present record adds the family Capparidaceae to the host plants of the Lycaenidae. This record also supports the postulated tight relationship between Silverline caterpillars and ants which attend them, and also demonstrates that chemical composition of the foodplant seems to have little relevance in this relation.

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33. BURROWING BEHAVIOUR OF THE SHORE CRAB *OCYPODA MACROCERA* H. MILNE EDWARDS FROM SUNDARBAN, WEST BENGAL

(*With one text-figure*)

Although brachyuran crabs comprise one of the major components of coastal macrofauna of the Sundarban delta, very little is known about the burrowing behaviour of these crabs, especially ocypodid crabs, from this region (Bakshi *et al.* 1980; Chakraborty *et al.* 1986; Bhunia *et al.* 1989; Mandal and Nandi, 1989; Nandi and Dev Roy, 1991; Nandi and Pramanik, 1994; Bairagi, 1995). This study deals with structure and distribution of burrows of the ocypodid crab, *Ocypoda macrocera* H. Milne Edwards.

Initially we studied the sea-shores of Bakkhali and Jambudwip in 1986, and subsequently reinvestigated Bakkhali beach, Sundarban, in 1996. In all, 188 burrows, 75 in 1986 and 113 in 1996 (Table 1) were studied, to ascertain the course of the burrows. The burrows were round slightly inclined and descending downwards (Fig. 1) and were found at the sand-flats between High Water Spring Tide (HWST) and High Water Neap Tide (HWNT). They usually had one external opening and occasionally up to three openings with inter-connections between them. The diameter of the external opening varied from 1.9 to 7.2 cm, descending to a depth of 7.9 to 46.2 cm (Table 1).

It is evident from Table 1 that more than 60% burrows were of 30 mm to 50 mm diameter. The depth of the burrow reaches its peak in case of burrow diameters ranging from 40 to 50 mm. This indicates that the crabs inhabiting burrows of 30 - 50 mm diameter were dominant over others. However, the crabs occupying burrows of 40 - 50 mm diameter appear to be more active burrowers.

The burrows were usually located on moist mid-littoral sand-flats having moisture content ranging from 11.8 - 23.0%, and burrow temperature 25.5 - 27.5 °C when air temperature was 20.0 - 22.5 °C. The number of burrows was found to vary from 2 - 10 per square metre with an average of 3.6 per sq. m. The maximum density was recorded at the middle of mid-littoral zone, wherein an average density of 6.5 per sq. m was encountered in January, 1996. The average density of burrows near the brick embankment at Bakkhali beach was also found to be on the higher side (5.9/sq. m.) in December 1986. But in 1996, the same site was found to be abandoned by the crabs, probably due to increased winter fishing activities around this area. The depth of burrows near the embankment site was invariably low and the crabs below the brick zone could be captured easily.

The literature on the ecological distribution of ocypodid crabs (Ono, 1965; Jones, 1972; Lighter, 1974; Crane, 1975; Warner, 1977; Murai *et al.* 1982, Macintosh, 1984) indicates that the

TABLE 1
DISTRIBUTION AND DEPTH OF BURROWS OF *OCYPODA MACROCERA* FROM SUNDARBAN

Burrow diameter (mm)	Burrow depth (cm)	Occurrence (%) of burrows at Bakkhali beach		Jambudwip
		1996 (N=113)	1986 (N=42)	1986 (N=33)
Up to 20 mm	9.0-10.5	1.7	2.4	3.0
20 to 30 mm	7.9-23.0	34.5	21.4	18.1
30 to 40 mm	11.1-32.6	39.8	33.3	30.3
40 to 50 mm	17.2 -46.2	20.3	33.3	36.3
50 to 60 mm	26.0-30.0	2.6	4.7	9.1
60 to 70 mm	26.0	0.9	2.4	3.0
70 to 80 mm		-	2.4	-

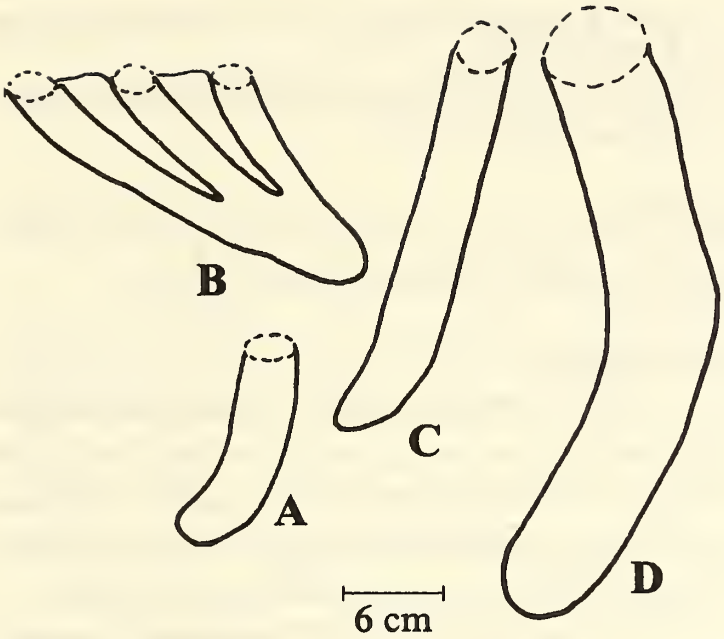

Fig. 1. *Ocypoda macrocera* burrows with single external opening (A, C, D) and three external openings (B).

distribution, depth and zonation of burrows are associated with the nature of the substratum, food availability, humidity, temperature, desiccation and water stresses of the intertidal environment. Human activities also play an important role in the distribution of ocypodid crabs. Thus the absence of this fascinating red shore crab species from some areas in the beach indicates their sensitivity to increased human interference and stresses the need for coastal zone management.

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34. DISTRIBUTION AND HOMING OF TREE SNAIL *RACHIS BENGALENSIS* LAMARCK (GASTROPODA) ON A NEW HOST PLANT

The tree snail *Rachis bengalensis* Lamarck (Gastropoda), was found only in six districts of West Bengal viz. Calcutta, Hooghly, Malda, North 24-Parganas, South 24-Parganas, and Purulia (FAUNA OF WEST BENGAL - STATE FAUNA SERIES-3; Part 9, MOLLUSCA; Z.S.I. Calcutta 1992; Raut & Biswas 1991. But the same species (Z.S.I., lot no. Moll-906 IR No. 20196) was also found by us from the school compound of Baishnabchak (15 km from Kolaghat Station, beside the river Rupnarayan) Midnapur, West Bengal, India. Despite thorough observations, the authors did not find this snail at any other places in this district except at Baishnabchak.

Though Gude (1914) described its taxonomic characters and Raut & Biswas (1991) described its natural history, our observations differ in a few points. According to Raut & Biswas (loc. cit.) the snails were very specific for hardwood trees viz. *Mangifera indica, Aegle marmelos, Zizyphus mauritiana, Erythrina indica, Citrus aurantifolia and Lannaea coromandelica.* But we observed that, although all the above mentioned trees were present in the garden in large numbers, the snail, *Rachis benghalensis* was found only on *Codiaeum variegatum* and *Aganosoma dichotoma.* Both these species are bushy shrubs. The snails were observed on these plants in colonies. They occasionally came down from their host plants at night, but never climbed *Mangifera indica, Aegle marmelos, Erythrina indica* and *Citrus aurantifolia* situated nearby. A few snails however, were observed occasionally on *Zizyphus mauritiana.*

From our observations, we can conclude that the snails are not very specific to their host plant. Moreover, their first preference was for *Codiaeum variegatum,* followed by *Aganosoma dichotoma, Zizyphus mauritiana* and other plant species.

According to our study these snails generally prefer semi-decomposed leaves rather than bark, as their food. Regarding homing, in most cases (85%) after foraging, they were able to come back to the same host plant day after day. The snails travelled about 240 (30 - 735 ± 86) cm, in a night, though the distance covered by this snail depends on its size and amount of rainfall during the night. Regarding egg laying, our findings are similar to those of Raut & Biswas (loc. cit.). We, however, observed that a few snails laid their eggs on the dorsal surface of the leaf of *Aganosoma dichotoma,* but these failed to hatch.

We thank Mr. K. V. Surya Rao, Deputy Director, Zoological Survey of India, Calcutta, for identification of the snail. We are also thankful to the Headmaster, Baishnabchak M.C. High School for his permission, co-operation and for the facilities provided, and lastly to the villagers of Baishnabchak.

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35. ON THE FIRST RECORD OF A CLADOCERAN, *LEYDIGIA ACANTHOCERCOIDES* (FISCHER 1854) (CHYDORIDAE) FROM ALIGARH, UTTAR PRADESH, INDIA

(With one text-figure)

In spite of the several publications dealing with the ecology of zooplankton (Khan and Siddiqui, 1974; Haque and Khan, 1994), no single satisfactory investigation regarding cladoceran diversity has been made from Aligarh (U.P.), India. Nine species belonging to six

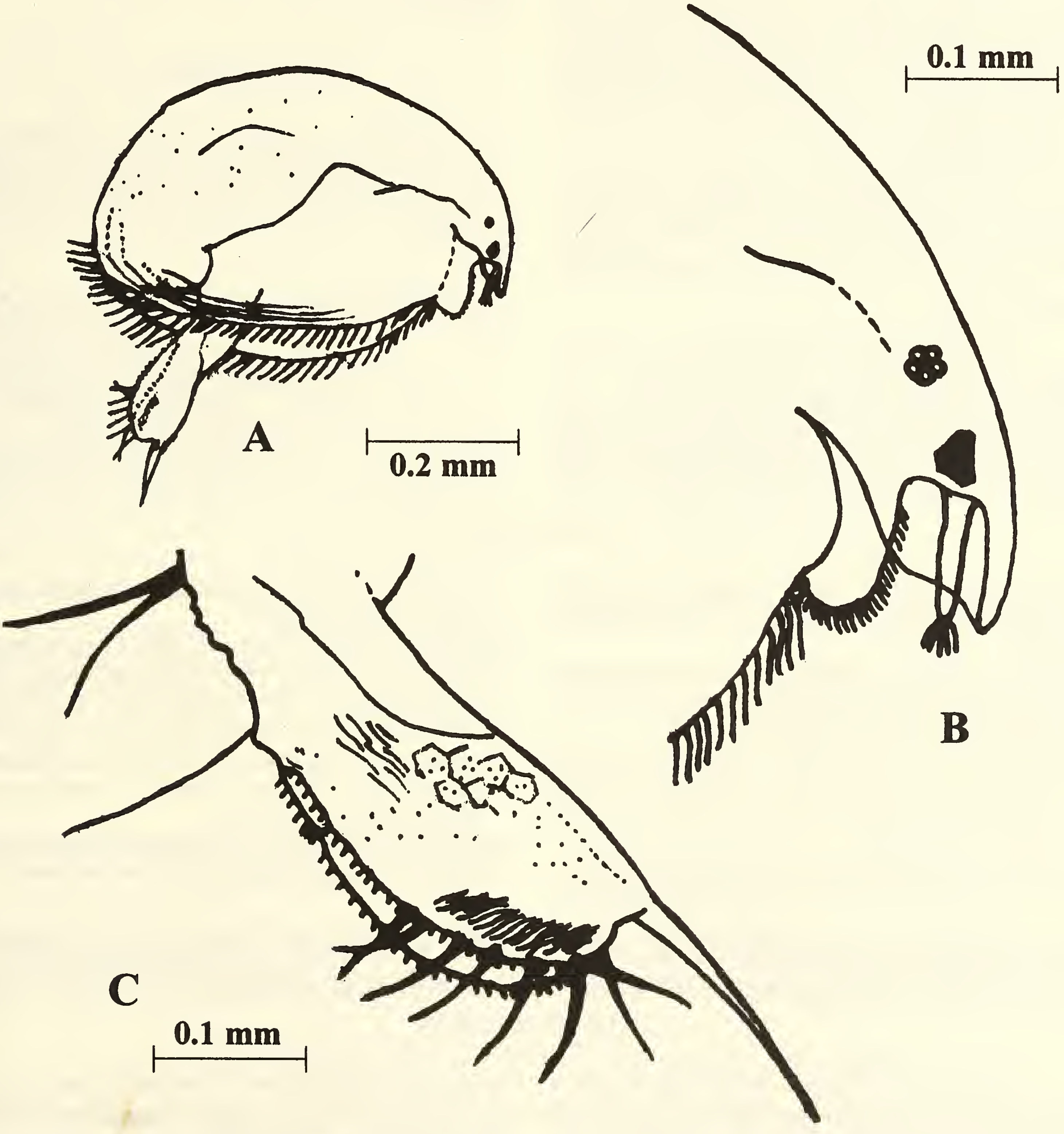

Fig. 1. *Leydigia acanthocercoides* A: Adult female; B: Head; C: Post-abdomen

genera of Cladocera have been reported from this region so far. We describe a rare cladoceran *Leydigia acanthocercoides* (Fischer), for the first time from this locality.

L. acanthocercoides is a widely distributed species in India (Nayar, 1971; Sharma, 1978; Michael and Sharma, 1988) and Sri Lanka (Rajapaksa and Fernando, 1982). In a study of Cladocera of the Indian subcontinent extending from 6°N (Sri Lanka) to 37°N (Kashmir) Lat. Fernando and Kanduru (1984) have included *L. acanthocercoides* in a group of cladocerans which occurred at all latitudes over 32-20° N except Srinagar.

The species inhabits aquatic weeds in polluted ponds. Specimens were preserved in 5% formalin, sketched with the help of camera lucida and measured. The species was identified after Battish (1992).

Female: Body measures 0.64 mm in length. Main features include oblong, oval shaped, compressed shell without crest with small extended head. Dorsal margin of the shell not evenly rounded. Shell valves with longitudinal striations on the postero-ventral edge. Entire ventral margin of valves with long cilia. Labral keel rhomboidal with rounded corners and provided with cilia. Ocellus pentagonal and larger than rounded eye. Post-abdomen large with numerous cilia, while expanded post-anal part with a number of large spines of varying lengths. Claws long and slender without basal spine. Colour pink in living specimen.

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36. EXTENDED DISTRIBUTION AND CONSERVATION OF THE RARE SEAWEED *TYDEMANIA EXPEDITIONIS* WEBER VAN BOSSE (CHLOROPHYCEAE) IN THE INDIAN REGION

The genus *Tydemania* Weber Van Bosse is represented by only two species viz. *T. gardineri* and *T. expeditionis* in the world, with their principal centres of distribution in Malayan archipelago, Philippines, Marshall Islands, Liu-Kiu Islands, Caroline Islands, Nancowry Island in the Bay of Bengal and Chagos Archipelago, Amirante Islands. From the Indian region, Srinivasan (1954) has reported this species from Nancowry Island of the Andaman-Nicobar archipelago in the Bay of Bengal. A perusal of the literature on Indian marine flora shows that no further collection of this species was made anywhere in the Indian region in the last four decades, thereby indicating its restricted distribution on the Indian coasts (Anonymous, 1983; Jagtap, 1985; Anonymous, 1987).

The authors, while studying the Marine Algal Flora of Andaman-Nicobar Islands, collected this taxon from Red Skin Island of Mahatma Gandhi Marine National Park near Port Blair, South Andaman, confirming its extended distribution in the Indian region. It is seen growing attached to coralline rocks in a sheltered bay, forming clumps below the low tide mark. Sometimes the alga may be mistaken for some marine animal with its thick caterpillar-like form, owing to the presence of characteristic sub-spheroid branched structures, the glomerules contiguously placed on the upright shoots.

Taxonomic Description: Coenocyte slightly calcified. Prostrate system thick branched, creeping rhizome, monosiphonous, constricted at shorter or longer intervals, up to 550 μ or more across. Rhizoids constricted at base, torulose. Flabella rare. Erect system with several erect shoots. Shoots with a series of glomerules giving a characteristic appearance to the alga. About 16 glomerules on each axial filament, each measuring 1 cm high and 1 cm broad. On drying, the alga takes on an ash colour, because of the feeble calcification of the glomerules.

Conservation: The natural habitats from where the authors and Srinivasan (1954) have reported *T. expeditionis* are known to show only a few patches of the alga and its collection is attended with a certain amount of risk. The coralline rocks on which this rare green alga grows are constantly dashed by waves, and are almost always completely submerged by the swell of the tide. The recent spurt in quarrying of coralline rocks for limestone has threatened rare marine flora. The declaration of the habitat of *T. expeditionis* as the Marine National Park near Port Blair is aimed at conserving many such species of rare occurrence and marine biological diversity.

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37. NOMENCLATURAL NOTES ON *OEDOGONIALES*

I received a copy of a book entitled OEDOGONIALES as a gift from the author, Prof. Ella A. Gonsalves (Retd.), during a visit to her residence in August 1996. While going through the book, a few nomenclatural errors have been noticed and the present paper deals with such nomenclatural changes.

1. ***Oedogonium candollei*** (Le Cl.) Breb. (1884) is the correct name for *Oedogonium fragile* Wittr. (1870) based on *Prolifera candollei* Le Cl. Mem. Mus. Paris 3: 473, pl. 23, (1817). Accordingly, the nomenclature of the varieties under this species has to be corrected as follows:

27 B. *Oedogonium candollei* (Le Cl.) Breb. var. *abyssinicum* (Hirn) Almeida comb. nov. = *O. fragile* Wittr. var. *abyssinicum* Hirn. Acta Soc. Sci. fenn. 27:97, t-6, f.35, 1900.

27 C. *Oedogonium candollei* (Le Cl.) Breb. var. *subdepressum* (Jao) Almeida, comb. nov. = *O. fragile* Wittr. var. *subdepressum* Jao, Bot. Bull. Acad. Sinica 2:51, f.2,K, 1948.

2. ***Oedogonium tumidulum*** Pringsh. (1855) is the correct name for *Oedogonium urbicum* Wittr. (1874). Actually, there are three homonyms as follows:

248. *Oedogonium tumidulum* (Kutz.) Wittr. (1874), based on *Conferva tumidulum* Kutz. (1833).

54. *Oedogonium tumidulum* Pringsh. (1855).

53. *Oedogonium tumidulum* (Roth.) Areschoug. (1864).

Prof. Gonzalves has accepted homonym no. 248 as the correct name on the basis that its basionym has priority. However, when Wittr. transferred it to the genus *Oedogonium*, the species epithet was already occupied and therefore cannot be used for the species. Consequently, the species number is provided herein with a new name *Oedogonium ellaianum* Almeida (nom. nov.) in honour of Prof. Ella Gonzalves.

As has been already accepted *Oedogonium upsaliense* (Wittr.) Tift (1939) is the correct name for *O. spetsbergene* Wittr. (1874).

3. ***Oedogonium spetsbergene*** Wittr. (1874) is the correct name for *O. vulgare* (Wittr.) Tift. (1939). The latter is based on *O. cryptoporum* var. *vulgare* Wittr. (1874). As the rule of priority does not apply outside the rank of the taxon, *O. vulgare* (Wittr.) Tiff. (1934) is the illegitimate name.

In consequence of the above situation, the following new combination is necessitated:

58B. *Oedogonium spetsbergene* Wittr. forma *robusta* (Bharad.) Almeida (comb. nov). = *O. vulgare* (Wittr.) Tiff. forma *robusta* Bharad., Proc. Indian Acad. Sci. B, 57:2, 1963.

4. ***Oedogonium vernale*** (Hassk.) Wittr. (1874), based on *Vesiculifera vernalis* Hassk. (1843), is the correct name for *O. crispum* (Hassk.) Wittr., based on a later name published in 1854. Hirn (1900) had accepted *V. vernalis* hassk. as part of the composite taxon *O. crispum* Wittr.

Consequently, the following infraspecific taxa require nomenclatural modifications:

80B. *Oedogonium vernale* (Hassk.) Wittr. var. *vernale* forma *inflatum* (Hirn.) Almeida, comb. nov.
= *O. crispum* (Hassk.) Wittr. var. *crispum* forma *inflatum* Hirn. Acta. Soc. Sci. fenn. 27: 161, pl. 25. f.140, 1990.

80C. *Oedogonium vernale* (Hassk.) Wittr. var *gracilescens* (Wittr.) Almeida, comb. nov. = *O. crispum* (Hassk.) Wittr. var. *gracilescens* Wittr. in Wittr. & Nordst., Alg. exs. No. 509, 1883.

80D. *Oedogonium vernale* (Hassk.) Wittr. var. *granulosum* (Nordst.) Almeida, comb. nov.
= *O. crispum* (Hassk.) Wittr. var. *granulosum* Nordst., Ofvers Vetensk. Akad. Forh. Stockh. 34: 24, 1877.

80E. *Oedogonium vernale* (Hassk.) Wittr. var. *hawaiense* (Nordst.) Almeida, comb. nov. = *O. crispum* (Hassk.) Wittr. var. *hawaiense* Nordst., Minneskr. Fys. Salisk. Lund. 7:20, pl.2. f. 9-10, 1878.

80F. *Oedogonium vernale* (Hassk.) Wittr. var. *uruguayense* (Mag. & Wille) Almeida, comb. nov.

= *O. crispum* (Hassk.) Wittr. var. *uruguayense* Mag. & Wille in Wille, Bih. svensk. Vetensk. Akad. Handl. 8:39, pl. 2, f. 63, 1884.

5. ***Oedogonium sphaericum*** Hall. (1905) is the correct name for *O. hallasiae* Tiff. (1934).

6. ***Oedogonium monticchii*** Fior-Mazz (1860) is the correct name for *O. inversum* Wittr. (1876) which necessitates the following new combination:

126B. *Oedogonium monticchii* Fior-Mazz. var. *minor* (Vill.) Almeida, comb. nov.
= *O. inversum* Wittr. var. *minor* Vill., Rev. gen. Bot. 60:677, f. 1, no. 12, 1953.

7. ***Vesiculifera compressa*** Hassk. (1845) is the earliest name for *Oedogonium calcareum* Cleve ex Wittr. (1840). This fact compels the following nomenclatural changes:

138. *Oedogonium compressum* (Hassk). Almeida, comb. nov.
= *Vesiculifera compressa* Hassk., Hist. Brit. Fresh-water Algae 204, t-53, f.4, 1845.

138B. *Oedogonium compressum* (Hassk.) Almeida var. *africanum* (Fremy) Almeida, comb. nov.
= *O. calcareum* Cleve var. *africanum* Fremy, Bull. Soc. Hist. Nat. Nat. Afr. Nord. 21:74, pl.6, f.9b, 1930.

8. ***Oedogonium calosporum*** Hirn (1895) is the correct name for *O. longiarticulatum* (Hansg.) Tiff. (1934), which is based on

O. crenulatocostatum Wittr. var. *longiarticulatum* Hansg. (1886).

As the rule of priority does not apply outside the rank of the taxon, *O. longiarticulatum* (Hansg.) Tiff. is an illegitimate name.

9. ***Oedogonium platygynum*** Wittr. var. *platygynum* forma *platygynum* is the correct name for *O. platygynum* Wittr. var. *platygynum* forma *obtusum* Hirn, as it includes the type *O. platygynum* Wittr. Consequently, the following combinations are essential:

279 A. *Oedogonium platygynum* Wittr. var. *platygynum* forma *major* (W. West.) Almeida, comb. nov.
= *O. platygynum* Wittr. forma *major* W. West, J. Linn. Soc. (Bot.) 29:109, pl. 18, f. 1, 1891.

279 B. ***Oedogonium platygynum*** Wittr. var. *platygynum* forma *platygynum.*
= *O. platygynum* Wittr. forma *obtusum* Hirn. Acta Soc. Sci. fenn. 27:277, pl.47, f. 303, 1900.

10. *Oedogonium borisianum* (Le cl.) Wittr. forma *tropicum* Isl. & Sarma (1965) has priority over *O. dachense* Gonzalves (1981). Therefore, the following new combination is proposed:

292. B ***Oedogonium borisianum*** (Le Cl.) Wittr. var. *borisianum* forma *tropicum* (Isl. & Sarma) Almeida, comb. nov.
= *O. borisianum* (Le Cl.) Wittr. forma *tropicum* Isl. & Sarma, Pak. J. biol. agric. Sci. 8:178, pl.3, f.32, 1965.
= *Oedogonium borisianum* (Le Cl.) Wittr. var. *borisianum* forma *dachense* Gonzalves, Oedogoniales 397, 1981.

11. ***Oedogonium vesicatum*** Link. (1856) is the correct name for *O. decipiens* Wittr. (1870). This necessitates the following new combinations:

381 B. *Oedogonium vesicatum* Link. var. *africanum* (Tiff.) Almeida, comb. nov.
= *O. decipiens* Wittr. var. *africanum* Tiff. Ohio. J. Sci. 29:74,1929.

381 C. *Oedogonium vesicatum* Link. var. *compressum* (W. West.) Almeida, comb. nov.
= *O. londinense* (Wittr.) Hirn. var. *compressum* W. West., J. Linn. Soc. (Bot.) 29: 110, pl. 18, f. 10-12,1891.
= *O. bernardense* Bates (1886).
= *O. decipiens* Wittr. var. *bernardense* (Bates) Hirn (1900).

Although *O. bernardense* Bates (1886) is a prior name, it is not legitimate under varietal rank, because the rule of priority does not apply outside the rank of the taxon.

381 D. *Oedogonium vesicatum* Link var. *dissimile* (Tiff.) Almeida, comb. nov.
= *O. decipiens* Wittr. var. *dissimile* (Hirn) Tiff. N. Amer. Flora II: 68, pl. 24, f. 384, 385, 1937.

12. ***Oedogonium vesicatum*** (Lyngb.) Wittr. (1874) is the later homonym of *O. vesicatum* Link (1856).

Although *Conferva vesicatum* Lyngb. (1819) had priority, the specific epithet *vesicatum* was pre-occupied in the genus *Oedogonium* and the name proposed by Wittr. becomes an illegitimate name.

Therefore the following new name is proposed:

485. *Oedogonium marselinae* Almeida, nom. nov.
= *O. vesicatum* (Lyng) Wittr., Nova Acta Soc. Sci. Upsal 9:39, 1874 (non, 1873).
= *Conferva vesicata* Lyng Tent. hydrophyth. danicae. Hafniae 140, pl. 47, f. D1, 1819.

This specific epithet proposed here is in honour of Marselin (Mr. M.R. Almeida) for his contribution to Indian Botany.

13. ***Bulbochaete variens*** Wittr. var. major (Pringsh.) Almeida, comb. nov.
= *Bulbochaete pygmaea* var. *major* Pringsh. Jb. Wiss. Bot. 1:74, pl. 6, f. 11, 1858.
= *B. variens* Wittr. var. *subsimplex* (Wittr.) Hirn. (1900).

Although *B. subsimplex* Wittr. (1870) is the prior name, under the rank of species, the varietal epithet *major* has priority.

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38. WILD SPECIES OF *ABELMOSCHUS* MEDIC. (MALVACEAE) FROM CENTRAL HIMALAYAN REGIONS OF INDIA

Abelmoschus Medic. (Malvaceae) has 15 species which have originated and are cultivated all over the tropics in Asia and Australia (Hooker 1874, Babu 1977, Santapau and Henry 1984). In India, only 8 species are available throughout the hotter parts (Anonymous 1985, 1991). After the most thorough study to date, Waalkes (1966) stated that the 14-15 species recognized earlier can be reduced to 6-7 species only. The National Bureau of Plant Genetic Resources (NBPGR) in its National Programme of crop-specific study on okra germplasm exploration in the eight hill districts of U.P., India from 1985 to 1992, procured, collected and assembled three species of wild okra from the Central Himalayan region.

The material collected was compared with authentic collections preserved in Northern circle, Botanical Survey of India, Dehradun (DD), specimens were identified as *Abelmoschus* *ficulneus* (L.) Wight & Arn. ex Wight, *A. manihot* ssp. *tetraphyllus* (Roxb. ex Hornem.) Borss. var. *pungens* (Roxb.) Hochr. and *A. moschatus* Medic. Through our evaluation programme during 1993 and 1994 at Regional Station-Bhowali, a comparative study of taxonomical characters, distribution, habitat, variability etc., of 3 wild species of okra is presented.

Uttar Pradesh Dist. Chamoli; BSD-57625, Basarkhet to Guigani, Dist. Almora; BSD-40180, Lachiwala, Dehradun.

Local uses: Tuberous roots are edible as fresh and green vegetable; sometimes stems and roots roasted; fibres used as twine and light cordage.

Abelmoschus moschatus Medic.

Local name: Kasturi Bhindi

Hispid herb 170 cm tall. Leaf orbicular-elliptic, palmate, cordate at base, 15.0 x 26.4 cm. Calyx 8 in numbers. Fruits 6.1 cm long, oblong-lanceolate, thinly hispid. Seeds 70 in number. Flowers yellow with crimson centre.

Fl. & Fr.: October-February

Habitat and Distribution: Negi- 1473/NIC-14154, Ranikhet, 1500 m, dist. Almora, 24.vi.1992; BSD-64615, Ghansali roadsides, 1200 m, Dist. Tehri.

General variability observed in wild okra, all the 3 species were short in length and of medium thickness, while the colour of fruits varied from green, purple to light purple. The height of plant ranged from tall to very tall types.

This report of their occurrence and distribution etc. forms an addition to the flora of Chamoli and Nainital, U.P. Himalaya (Gupta 1968, Naithani 1984) and to the other temperate Himalayan flora of India (Collett 1902, Duthie 1906, Polunin and Stainton 1984).

A brief note is provided here to facilitate further collection and easy identification. These three species of wild relatives of okra have been grown, multiplied and maintained at NBPGR, Regional Station-Bhowali.

Abelmoschus ficulneus (L.) Wight & Arn. ex Wight

Local names: Kapasi, Jangli Bhindi, Ran-Bhindi.

Much branched, prickly herb 185 cm tall. Leaf rounded, cordate at base, upper leaves palmate, 15.0 x 23.4 cm. Calyx 5 in number. Fruits 3.6 cm long, tomentose, ovoid, viscid hairs when green. Seeds 31 in number. Flowers light yellow with pink centre.

Fl. & Fr.: October-January

Habitat and Distribution: Pant-233, Chanoda, roadsides, 1200 m, Dist. Almora, 20.x.1985; BSD-934, Bindal river bank, Dist. Dehradun; BSD-3337, Motherwala, Dist. Dehradun; BSD-1095, Song river bed, 600 m, Dist. Dehradun; BSD-34004, Rispina, Dehradun; BSD-52420, Chopta, Kumaon; BSD-57507, Dwarhat, 1500 m, Dist. Almora; BSD-78086, Dam site, Dhauliganga dam, Dist. Pithoragarh.

Local uses: Fresh, green, tender fruits cooked as vegetables.

Abelmoschus manihot ssp. *tetraphyllus* (Roxb.) ex Hornem. Borss. var. *pungens* (Roxb.) Hochr.

Local names: Kapasi, Jangli Bhindi

Bristly herb 255 cm high. Leaf ovate, sub-orbicular, palmate, cordate at base, 24.0 x 41.7 cm. Calyx 4 in number. Fruits 5.2 cm long, oblong, pointed hispid. Seeds 59 in number. Flowers yellow with purple centre.

Fl. & Fr.: September-December.

Habitat and Distribution: Negi-882, Karanprayag, 1150 m, Dist. Chamoli, 1.x.1988 Tewari *et al.* 1667/NIC-14490, Near Kaliasaur landslides, 500 m, Dist. Pauri; Negi, Dogaon, 800 m, Dist. Nainital, Oct. 1988 (sic.); BSD-53758.

ACKNOWLEDGEMENTS

We are thankful to the Director, NBPGR (ICAR), Pusa Campus, New Delhi, Dr. K.P.S. Chandel, for providing facilities and encouragement and Mr. V.K. Pant, Technical Officer, for maintaining the germplasm.

February 13, 1997

K.S. NEGI
K.C. PANT
National Bureau of Plant
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39. USE OF *LINDENBERGIA MURARIA* LEAVES AND *IMPATIENS BALSAMINA* FLOWERS AS A SUBSTITUTE FOR HENNA

Leaves of *Lawsonia inermis* Linn. yield a colouring matter called "henna" which is used by women in various ways. But, *Lawsonia inermis* is not easily available in the tribal belt of southern Rajasthan. The juice of the leaves of *Lindenbergia muraria* (Roxb. ex. D.Don) P. Bruehl (Family Scrophulariaceae) is used as a substitute for leaves of *L. inermis* by the *Bhils* of southern Rajasthan. Fresh leaves of the plant are ground into a paste and the juice is extracted. It is stored in cups made of leaves of *Butea monosperma*. The juice is applied to the palms and fingers to produce the henna stain. The plant *L. muraria* is found on old walls, crevices of rocks near moist situations, and near drains at moist rocky edges. The local name is "Kormi Mehndi" or "Kali Mehndi". Similarly a paste of flowers flowers of *Impatiens balsamina* L. (Family Balsminaceae) is used as a substitute for "henna". This plant is locally called "Timda" in southern Rajasthan.

May 13, 1997

SATISH KUMAR SHARMA
Range Forest Officer,
Aravalli Afforestation Project,
Jhadol (F.), Dist. Udaipur (Raj.) Pin 313 702.

40. *AMARANTHUS PALMERI* WATS. A NEW RECORD FOR MAHARASHTRA

During plant collection trips in Dhule dist. (Maharashtra) the author gathered some interesting Amaranthaceae in wastelands and along highways near Dhule city. After critical study of the literature, the specimens have been identified as *Amaranthus palmeri* Wats. hitherto unreported from the state of Maharashtra (Karthikeyan, 1981; Pradhan pers. comm.). The taxon is an exotic floral element, denizen of southwest United States. It is fast naturalising and forms pure stands, usually replacing the local plant species. The great probability of its extending distribution in the district can not be overlooked, the present site being at the crossroads of two national highways. The taxon is likely to distribute widely due to very large seed set and viability.

In this communication the detailed description of the taxon is given to facilitate easy identification. It also gives the phenology and habitat along with the possibility of its dispersal. The voucher herbarium specimens are deposited in the herbarium of the College.

Amaranthus palmeri Wats. in Proc. Am. Acad. 12:274.1877; Saur in Journ. Indian bot. Soc. 43: 573-756. 1922; Shetty & Singh, Fl. Rajasthan 2:728-729.1991.

Erect, dioecious, profusely branched annuals, 90 to 220 cm tall, stem pale green, sometimes tinged pink at nodes, sulcate-angular, nearly glabrous, main stem minutely tuberculate and dark pink-purple at base. Leaves ovate, rhombic to lanceolate, lamina upto 12 x 7 cm, oblique at base, apex obtuse, mucronate, mucro-hyaline, upto 1 mm long, margin entire, undulate, pubescent when young, glabrous at maturity, prominently nerved and paler beneath, petiole upto 8 cm long, channeled.

Flowers small, green, in terminal branched spikes and in small axillary or rarely extra-axillary spicate clusters; terminal spike upto 70 cm in length, sometimes the main central spike branched towards base or rarely towards the top, pink at fruiting. Female Flowers: Tepals 2-3 mm long, 1-nerved, oblong to obovate or spathulate, bracteoles 1.5 to 3 times as long as tepals, spine-tipped, rigid, bent at maturity, gynaecium paler, styles two, ovule solitary. Male Flowers: Tepals 2-3 mm long, 1-nerved, oblong, acute-mucronate, bracteoles weaker and shorter than the one in pistillate flowers, anthers yellow, dithecous. Capsules subglobose, paler, 2-beaked, rugose at top, upto 2 mm long excluding beaks, dehiscence circumscissile, seed solitary, 1.2 mm across, rounded to obovate, biconvex, margined, shining, dark red-brown.

Locality: Dhule 68, 1401.

Fl. & Fr.: September-December.

Naturalised in neglected corners of fields, wasteland and along roads in exposed sunny places and under partial shade.

I am thankful to Dr. S.G. Pradhan, BSI (WC), Pune for information and to the Principal, Mr. B.M. Patil for facilities.

February 19, 1997

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BOMBAY NATURAL HISTORY SOCIETY

Hornbill House, Dr. Sálim Ali Chowk, Shaheed Bhagat Singh Road, Bombay 400 023.

112TH ANNUAL REPORT AND ACCOUNTS FOR THE YEAR 1ST APRIL 1995 TO 31ST MARCH 1996

EXECUTIVE COMMITTEE 1995-96

President Mr. B.G. Deshmukh, IAS (Retd.)
Vice Presidents Mrs. D.S. Variava Dr. P.R. Saraiya
Mr. D.S. Chavda
Hon. Secretary Dr. A.M. Bhagwat
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Director Dr. Jay S. Samant

MEMBERS FROM 1995-1996

Mr. M.R. Almeida, Mr. Yogi Andley, Dr. B.F. Chhapgar, Mr. J.C. Daniel
Dr. Arun Joshi, Dr. A. Kothari, Mr. K.P. Karamchandani, Dr. Shashi Menon,
Dr. A.N.D. Nanavati, Mr. Ulhas Rane, Dr. Rajendra Shinde, Dr. V.S. Vijayan
The Secretary, Ministry of Environment & Forests, Govt. of India,
The Director of Archaeology & Museums,
Govt. of Maharashtra.

SPECIAL INVITEE

Mr. Humayun Abdulali

ADVISORY COMMITTEE

Dr. D.K. Lahiri Choudhury, Prof. Raghavendra Gadagkar, Dr. Anil Gore, Prof. K.C. Malhotra,
Lt. Gen. Baljit Singh, AVSM, VSM, Mr. Samar Singh, Mr. Romulus Whitaker.

AUDITORS

M/s Habib and Company, Chartered Accountants, Bombay.

REPORT OF THE SUB-COMMITTEES OF THE EXECUTIVE COMMITTEE

The following office-bearers were Ex-officio on all the Sub-Committees:

Hon. Secretary	Dr. Ashok M. Bhagwat
Hon. Treasurer	Mr. Sunil R. Zaveri
Director	Dr. Jay S. Samant

PUBLICATIONS SUB-COMMITTEE

Chairman	Dr. Jay Samant (Director)
Members	Dr. P.R. Saraiya (Vice President)
	Dr. B.F. Chhapgar
	Mr. J.C. Daniel
Convenor	Dr. Gayatri Ugra (Publications Officer)

The year 1995-96 augured well for the Publications Department as there were satisfactory sales of all titles, especially the updated edition of the **Pictorial Guide to the Birds of the Indian Subcontinent**, 1995. This year two new titles were published and released.

The Pictorial Guide: The **Pictorial Guide to the Birds of the Indian Subcontinent**, 1995, which was released on 11th November, 1995, by the Hon. Mayor of Mumbai, marked the beginning of the Dr. Sálim Ali Centenary celebrations.

The Book of Indian Birds: The revision of the **Book of Indian Birds** also reached completion and the book was printed and made ready for release as a part of the Centenary celebrations.

A Guide to the Cranes of India (New title by Prakash Gole): This booklet covering the six species of cranes found in India, was released at the Sálim Ali International seminar on 12th February, 1996, by Shri Mohan Dharia.

A Week with Elephants (New title edited by J.C. Daniel and Hemant Datye): The proceedings of an International Seminar on the Asian Elephant was published and released at the Sálim Ali International Seminar on 15th February, 1996.

Other Titles: The Publications Section continues to publish its popular titles such as the **Book of Indian Animals, Book of Indian Reptiles, Some Beautiful Indian Trees** and **Some Beautiful Indian Climbers and Shrubs.**

BNHS titles are marketed by Oxford University Press. Meetings were held with OUP to determine the terms and conditions for renewal of the Sale Agreement, which was to expire in September 1996. The Royalty received for the year is Rs 9,30,443.00.

It is to be noted that the pricing policy of the Society has been formulated keeping in mind the objectives of the BNHS, to promote nature education with the help of reasonably priced but scientifically unmatched publications.

New titles under production

Seaside Stories by B F Chhapgar

Illustrated Flora of Keoladeo National Park by V P Prasad *et al.*

The Book of Indian Trees by K C Sahni

A Field Guide to the Butterflies of India by N Chaturvedi & Isaac Kehimkar

The Book of Indian Seashells by Deepak Apte

Hornbill

Notable success was achieved in the publication of six issues of **Hornbill**, including a special issue to commemorate Dr. Sálim Ali Centenary year. This issue was released on 12th February, 1996, at the Sálim Ali International Seminar. The **Hornbill** issues 1994 (3) and (4), and 1995 (1), (2), (3) and (4) were published, while 1996 (1) was sent into press.

Though the **Hornbill** is supported by funds from the Mehta Scientific Education and Research Trust and the Seth Purshotam Das Thakurdas and Divaliba Charitable Trust, the publication is a drain on the Society's funds. Some support has been obtained through advertisements. Since the **Hornbill** is the sole benefit for most of the outstation members, it is felt necessary to make it of as high quality, both editorially and in production value, as the available resources permit. This can be substantiated by the comparative quotations available for perusal.

Journal

The oldest scientific Journal on the natural history of the Indian Subcontinent, the **JBNHS** Vol. 92, no. 1, 2 and 3 were published, covering the year 1995. The first issue for 1996, Vol. 93, no. 1, has also been published. The Department of Science and Technology, Govt. of India, has released a grant of Rs. 50,000 as financial aid for the **Journal**.

The shortfall of funds for the **Hornbill** and **Journal** are met by the BNHS as these publications are crucial to the dissemination of scientific information and popular interest.

M/s Jasra Graphics Pvt Ltd. were requested and they agreed to give a 30% rebate on scanning charges, amounting to Rs.74,843.00 for the year on **Hornbill**.

M/s Stusa Mudra Pvt Ltd. were requested and they agreed to give a discount of 18% on printing charges for the **Sálim Ali Special Hornbill**, amounting to Rs 7,600.00.

PRODUCTS SUB-COMMITTEE

Chairperson	Mrs. D. S. Variava (Vice-President)
Members	Ms. Anjana Thadani
	Ms. Agnes Rajesh
	Ms. Juliet Mendonca
	Ms. Celina Carvalho
	Mr. Francis D'costa
Convenor	Mr. Joslin Rodrigues (Products Executive)

The Products Sub-Committee continued to fulfill its objective of producing cards and calendars that reflect the Society's commitment to excellence in quality and reasonable prices.

Inspite of ups and downs in production, total 2,62,247 cards were sold and out of these cards, 2,43,333 cards were sold in Mumbai and 19,414 were sold outside Mumbai.

In keeping with the previous years' calendar theme of **Gems from Nature**, this year's theme was **Birds**. The exquisite bird illustrations were from the rare collection of John Gould's paintings. This calendar was dedicated to Dr. Sálim Ali, being his birth centenary year. This product was highly appreciated and altogether 20,873 calendars were sold. 3000 of these were sent to Russia by Lupin Laboratories.

A portfolio of 4 special prints by John Gould from the rare book collection was produced .It was released on 16th December during the inauguration of the Rare Books Exhibition by the Maharana of Kutch. It was priced at Rs. 280.00 per set. Since this product was released late in the year, it could not pick up on sales. Nevertheless the total number of prints sold was 2,511.

The Products section produced 2 special calendars for Colour-Chem and Videocon. 10,000 corporate wall calendars were specially produced and designed in the BNHS on the theme **Orchids** for Colour-Chem. For Videocon, 1 lakh corporate wall calendars were produced on the theme **The World of Videocon**.

The Products Committee appreciates the co-operation of all concerned members of the staff and volunteers to produce high quality results.

The Products section would be highly obliged to the members of the BNHS for informing them of organisations which make special calendars, so that they could be approached for these jobs which would bring further contribution to the Society.

NATURE EDUCATION, PROGRAMMES, MEMBERSHIP SUB-COMMITTEE

Chairman	Mr. Ulhas Rane
Members	Dr. Ashok Kothari
	Dr. Arun Joshi
	Dr. Shashi Menon
	Mr. V.K. Paralkar
	Mr. T.V. Sowrirajan
	Mr. Vilas Shingre
	Mr. Naresh Chaturvedi (Curator)
	Mr. P.B. Shekar (Programme Officer)
	Mr. Deepak Apte (Nature Education Officer)
	Mrs. Caroline Vincent (Membership Officer)

MEMBERSHIP

This year altogether 1078 new members were elected during the year 1995-96. The total number of annual members who renewed their membership was 1432.

This year there is an overall increase in all the membership categories. This can be directly attributed to the publicity BNHS received during the celebration of Dr. Sálim Ali's Birth Centenary, which commenced on the 12th of November 1995.

Issuing laminated membership cards to all Life Members on submission of their photographs was initiated.

The Membership Department is grateful to all the members who helped in enrolling new members and publicising the Society's activities.

Type of membership	Year		
	1993	1994-95	1995-96
Ordinary (I)*	1663	1677	1862
Student	480	409	496
Life (I)*	1345	1421	1474
Corporate	54	7	-
Compound Corporate	111	111	111
Family	8	Discontinued	Discontinued
Ordinary (F)$	24	25	46
Life (F)$	211	192	207
Institutional	-	77	95

* = Indian members; **F$** = Foreign members including from SAARC countries

PROGRAMMES

Annual Nature Camps:

Annual nature camps are very popular among members and no sooner they are announced, the seats get booked within half a day on the registration day. For such camps, there is always a reserved quota for outstation members.This year the highlights of the Programmes for members were the Annual Camps held at Kaziranga National Park, Wildlife Sanctuaries of South India (Dandeli, Ranganathittu, Nagarhole, Topslip, Parambikulam), Castlerock in North Kanara, Ratnagiri, Great Indian Bustard Sanctuary (Solapur), Phansad Wildlife Sanctuary, Bhandardara (Wilson Dam), Palamau Tiger Reserve (Solar Eclipse observation), Nandur-Madmeshwar, Bhimashankar Wildlife Sanctuary and Marleshwar sacred groves.

Overnight Nature Camps:

These camps are held on weekends or a holiday. Such camps were held at Malavali (Lonavala), Malshej Ghat and Ulhas River Valley.

Nature Walks:

Such walks are usually ideal for beginners and are held during weekends. The outings were arranged at BNHS land, Karnala Bird Sanctuary, Godrej Land (mangroves & birds), Rajbhavan, Sanjay Gandhi National Park, Tungareshwar, Kondgaon Lake and Mahim Nature Park. Dusk walks were also held in the Sanjay Gandhi National Park and BNHS land.

Besides nature walks, Shramdan and nature study programmes are held at the BNHS land regularly every month. This programme initiated nursery development and water conservation with members' participation.

Films / Slides:

Every Thursday of the year video as well as 16 mm films on various natural history subjects were screened during the year. Talks illustrated with slide shows were given by invited guest speakers, BNHS members and staff.

Earth Day (22nd April):

On this occasion Mr. R B Giri, Forester, Melghat was invited to give a talk on Medicinal Plants of Melghat Tiger Reserve. On the day before, a public meeting was held to highlight the plight of the Tiger as part of the TIGER LINK.

World Environment Day (5th June)

To commemorate this day, an exhibition of wildlife photographs by Mr Sudheer Agashe, an active BNHS member, was arranged at Hornbill House from 5th June to 8th June.

Wildlife Week

The first week of October was celebrated as Wildlife Week, when a Nature Film Festival was held. Wildlife Films were screened during this week throughout the day at regular intervals. Viewing was open to the general public besides members.

NATURE EDUCATION

Summer camps

As part of the Summer Vacation Programme, a camp was arranged at Tansa Sanctuary which was attended by 32 students. 57 species of birds were seen during the three-day camp. Pug marks of various animals were observed. Demonstration on taking pug mark casts was shown. Since it was summer, all afternoon programmes were held indoors. A session on line drawings was enjoyed by the participants. Quiz competition was well participated. A very informative session on nature education and students participation in conservation efforts was conducted.

Another summer camp was attended at Khandala organised by the YWCA. Two trails were led in the nearby forest area. Also two lecture sessions were arranged on nature education. The camp was attended by 35 school students.

Post Monsoon Camp

Camping during monsoon is an unique experience. This year 60 students alongwith 4 teachers enjoyed the monsoon at Tansa Wildlife Sanctuary. Various activities like trails, sessions on pond ecosystem and forest ecosystem were held.

Nature Rambles

In all 29 field trips to various places like Sanjay Gandhi National Park, Tungareshwar, Karnala and Arnala, Juhu beach, BNHS land at Goregaon were conducted. Of these 29 trips, 2 were for college students and rest were for school students of standards 8-10. 850 students and 60 teachers participated in nature rambles throughout the year.

A special nature trail was arranged for the hearing and speech impaired children. The programme was well participated and was greatly appreciated by their principal so much so that they are now planning to hold these programmes regularly.

Talks illustrated with slides/films

Talks illustrated with slides on various aspects of natural history and nature education were conducted in schools, colleges and for members. Out of the eleven slide shows held, five were for school students, two for college students and two for members. A total of 1255 students attended the slide shows.

Seven wildlife films were screened in schools and colleges, and besides these activities, two snake shows, two visits to the BNHS collections, two visits to the aquarium and two to the zoo were also conducted. Of these, snake shows were most popular and attended by maximum number of students. A total of 1080 students attended these programmes.

Workshop

A three-day workshop arranged by CEP was attended by the Education Officer at Hornbill House and at BNHS land. This workshop helped in planning activities for students.

Certificate Course

This year a one-year Correspondence Certificate Course in Ornithology was successfully launched. A total of 62 participants registered for the course. The first four lessons have been sent to the participants. The course is being conducted as part of the fund raising activity.

Special Programme

Tree Plantation activity was undertaken on 23rd July. A batch of 25 students participated in this programme.

Other activities:

122 species of sea shells from BNHS collections were identified and numbered.

The Education Officer was invited to interview candidates for the Homi Bhabha Young Scientist Award at Parle college.

National Painting Competition

As part of the Sálim Ali Centenary Celebrations a national painting competition for school students was arranged. Over 4000 entries were received from thirteen centres from all over India. The prize distribution ceremony was arranged on 5th June 1996. This activity was sponsored by CEP and conducted with assistance from the Nature Education Department.

Exhibitions

Mobile exhibitions were arranged at Saraswati High School and V K Krishna Menon College to create nature awareness among students and staff. The programme was attended by about 1500 students.

Membership drive

Two stalls were arranged as part of the membership drive programme, one at S C College and another at Singhania High School. A total of 10 new members (student) registered during these programmes.

In all a total of 9800 students, 1200 others (general public), and 70 teachers participated in various activities like camps, nature rambles, slide/film shows, snake shows, workshops, painting competition, exhibitions etc. This year seven new schools were enrolled in the Nature Education Scheme.

CONSERVATION EDUCATION PROJECT

Chairman	Dr. Shashi Menon
Members	Mr. Ramesh Dandekar Mr. P.V. Bole (Sp.Invitee)
Convenor	Mr. Arvind Karandikar (Proj. Mgr.) Mr. T. K. Bharathan (Proj. Adm. Mgr.)

Activity Report

In the three project areas the teams conducted 87 educational programmes, designed, field-tested and developed various educational material and interacted at programme level with different agencies in particular area. Efforts were also made to liaise with agencies which have development interventions available with them and some introductions were made possible with the target groups taking their help. Improved stoves, plantations, biogas plants, smokeless stoves are such examples.

Rapport with government agencies and non-government organisations has started yielding positive results in the form of small projects being supported by the government departments, activities being executed jointly with the agencies and periodical invitations forwarded by these agencies to the CEP staff as resource persons (atleast 23 major assignments).

BNHS celebrated the year starting from 12th November 1995 as the birth centenary year of Dr. Sálim Ali. To pay a tribute to this visionary the CEP organised a national painting competition on 25th February 1996 to raise awareness about environment among school children. Over 4000 children from thirteen cities of India participated in the event. A prize distribution ceremony was planned on 5th June 1996, World Environment Day.

Conservation Education Centre (CEC)

CEC construction activity at Goregaon was continued and efforts were made to expedite the matters at government level. At the end of the reporting period the construction is 95 percent completed. It is expected to be completed by end of April 1996 and it is planned to shift to the CEC in May 1996.

At the request of the British Council Division, an independent agency was appointed in May 1995 to conduct the technical audit of the CEC construction and it submitted its final report in July 1995 which brought out a few procedural lacunae while expressing overall satisfaction on the quality of construction.

The interior furniture and installation of display techniques were taken up simultaneously and are expected to be completed by end of April 1996. Water connection is now available on site and electrical connection is expected by May 1996.

Meanwhile the land was marked with five nature trails, designed and worked upon, and the groups of students and teachers started visiting the centre (12 educational programmes in the reporting period) to participate in educational programmes started by the CEP team. The response is encouraging and plans for optimum utilisation of the CEC in the forthcoming academic year (June 1996 - May 1997) are being finalised.

With the full year support forthcoming from ODA for centre's operation, it is envisaged that the centre including the mobile units, will be fully operational by the end of the project period.

Training and Workshops

The project team met in Gudalur in July 1995 to assess the project progress and to plan further programmes, mainly development of educational resources. The Indian Project Co-ordinator and BCD Project Manager were also present for the meeting.

During September 1995, Mr. Kevin Roberts from RSPB UK visited the CEP and a workshop was held with the project team on centre operation and management. CEC management plan was designed and drafts of various parts of the plan viz. education plan, reserve plan, food and catering are ready. The final management plan based on these drafts are being prepared by the project team.

There were two visits of the UK technical co-ordinator of the project, Mr David Elcome during the reporting period, first in October 1995 and second in February 1996. In October, Mr Elcome traveled to all the three field stations and assessed the progress. During his stay in Mumbai, the BCD had arranged a half-day meeting of various individuals from BNHS and BCD interested in the CEP and overall progress and future plans were discussed during the visit.

Impact of the Project

The three mobile field education units have been operational and working satisfactorily. More than 250 educational programmes were conducted since launching of the project and were received well by the target groups like local community, schools, tourists and local NGOs. Change in attitudes of all target groups was noticed, especially when the interactions with them was constant.

Several groups were formed like 'Eco Clubs', or 'Birdwatchers Club' of like-minded people, so that they could act upon various issues of environmental protection. Such groups, even informally formed out of the project, provide sufficient support towards conservation oriented activities. These groups on their own initiatives have already started planning action against commercial tree felling, nuisance by tourists to wildlife, cruelty to animals and similar problems. They have also adopted several environment-friendly practices such as using fuel-efficient stove/chullah, installation of biogas plants, improved breed of cattle, energy plantations besides general tree planting and composting to replace chemicals in agriculture. Willingness to accept these techniques comes out of interaction of the CEP team with them through educational programmes.

Change in attitudes of Park Management

The major change visible at the park management level, at least at two of the project areas, was willingness on the managers' part to initiate discussion and deliberations with local people regarding various issues concerning the park and the people.

Bharatpur: The park manager has over the last year participated in some of the CEP educational programmes, held informal discussions with local people, appointed some of the newly trained local youths as naturalists or field guides by granting licenses and requested BNHS to have joint programmes with the forest department in education and training.

Mumbai: The park manager has shown interest in considering BNHS as an advisory agency or implementing agency in revitalising the existing interpretation centre at Sanjay Gandhi National Park.

Gudalur: The forest department invited CEP team to discuss possibility of taking up educational programmes for people living in and on the periphery of the sanctuary and sanctioned a pilot project of Rs.10,000/- in March 96.

Women always have participated in large numbers in the educational programmes of CEP, especially in fuel related programmes like demonstrations of improved stoves and biogas technology.

Sponsorship

Initiative was taken to arrange for short and long-term sponsorship for the Conservation Education Centre (CEC) at Goregaon. After the culmination of the ODA funded CEP, the running cost of the CEC at Goregaon and the mobile unit will be the responsibility of the BNHS. In view of this, packages are being developed to be offered to potential sponsors.

Consultancy

The project has made a good impact on the local NGOs and Government officials. It was also given wide coverage in the recent International Seminar on "Conservation of Avifauna of Wetlands and Grasslands" in February 1996. Slowly there has been response shown by the concerned Government agencies in giving consultancy work to the BNHS through our Conservation Education Project (CEP), e.g. 1. Department of Forest, Tamil Nadu has requested the CEP-Gudalur Team to undertake a short awareness survey around Mudumalai Wildlife Sanctuary (Rs.10,000/-); 2. The Punjab State Forest Department has enquired about Harike (Ramsar Site) and Ropar Wetlands. Maharashtra Forest Department has expressed willingness, after an initial meeting with the Co-ordinator of the Project, to assign development of the two Nature Interpretation Centres in and around Sanjay Gandhi National Park with the help of World Bank funded Maharashtra Forestry Project and Thane Municipal Corporation respectively. Wetland International - Asia Pacific has supported a short-term nature awareness programme at Point Calimere, a wetland of international significance for migratory birds.

UNIVERSITY STUDY SUB-COMMITTEE

Chairman	Dr. Jay S Samant (Director)
Members	Mr. M.R. Almeida
	Prof. P.V. Bole
	Dr. B.F. Chhapgar
	Mr. J.C. Daniel
	Mr. N. Chaturvedi (Curator)
Convenor	Mr. Deepak Apte (Nature Education Officer)

In the beginning of the year, the circular regarding admissions to the M.Sc. and Ph.D. courses was sent to colleges from Mumbai and major research institutes all over India. In response to this, 15 applications for Ph.D. and 9 for M.Sc. were received.

The following students were registered in the year for M.Sc. and Ph.D. courses.

	Students	Course	Guide
1.	Mr. Gurmit Singh	Zoology Ph.D.	Dr. Jay Samant
2.	Mr. Y.S. Shaikh	Zoology Ph.D.	Dr. Jay Samant
3.	Ms. Reshma Suri	Zoology Ph.D.	Dr. Jay Samant
4.	Ms. Latika Nath	Zoology Ph.D.	Dr. Jay Samant
5.	Mr. Paresh Parab	Zoology M.Sc.	Mr. N. Chaturvedi
6.	Ms. Reshma Shelatkar	Zoology M.Sc.	Dr. Vibhu Prakash

Mr M. R. Almeida was recognised by the University of Bombay as Research Guide for Ph.D. students for botany at the BNHS. Similarly, Dr. S.B. Chapekar and Dr. Sanjay Deshmukh received recognition for taking M.Sc. and Ph.D. students at the BNHS.

LIBRARY SUB-COMMITTEE

Chairman	Dr. Ashok Kothari
Members	Dr. B.F. Chhapgar
	Ms. Mehru Dubhash
	Ms. Doreen D'Sa
	Mr. V.K. Paralkar
	Mr. Vilas Shingre
	Mr. N. Chaturvedi (Curator)
Convenor	Ms. Shubhangi Puradkar (Asst. Librarian)

Altogether, 1262 new books were added to the library, including 265 bound volumes of periodicals, 82 books purchased for the library, 353 books purchased under various projects, 550 books received as donation or complimentary and 12 books for review. Complimentary copies were received from authors, publishers, and institutions.

Two new periodicals were subscribed, three new periodicals were received in exchange for the BNHS **Journal** and two on complimentary basis. That brings the total of national and international periodicals received in the library to 177.

As the process of setting up of audio-visual library is in progress, this year 150 slide jackets were purchased to store slides. The slides were arranged according to the respective topics on natural history and conservation. 40 video cassettes have been catalogued on the computer. These are issued only to educational institutions at a nominal charge and deposit.

Sale of damaged and withdrawn books, as recommended by the Library Sub-Committee and approved by the Executive Committee was organised.

An exhibition of Rare Books, inaugurated by the Maharao of Kutch, was held at Hornbill House as part of the Sálim Ali Centenary Celebrations. The exhibition was well received by the media and public.

The Microfiche Reader-cum-Printer service is continuously being used for referring and photocopying articles from old volumes of the JBNHS.

All the work concerning the preparation of the publication **Sálim Ali's India** is being done in the library, which includes selecting, listing, arranging of articles, photographing plates, and correspondence with the sponsors, printers and others involved in the project.

The following donors donated books to the library:

Book Donors	No.	Book Donors	No.
Dr. Jay Samant	32	Dr. Ashok Kothari	3
Mr. H G Kamalesh	13	CEE	2
W W F	10	Mr. K K Maheshwari	2
Business India	6	Ms. A Patel	1
YUVA	4	Mr. Digveerendrasinh Solanki	1

RESEARCH AND COLLECTIONS SUB-COMMITTEE

Chairman	Mr M R Almeida
Members	Mr Humayun Abdulali (Emeritus Naturalist)
	Dr P S Saraiya (Vice President)
	Dr B F Chhapgar
	Mr J C Daniel
	Mr K P Karamchandani
	Dr Shashi Menon
	Dr Rajendra Shinde
Convenor	Mr S R Nayak (Project Secretary)

Three meetings of Research and Collections Sub-Committee were held during the year.

COLLECTIONS

This year several distinguished visitors visited the Collections and among them were Shri R T Kadam, Mayor of Mumbai, Shri Govind Swaroop, IAS, Secretary, Cultural Affairs, Government of Maharashtra, Mr. M.F. Ahemed, IG Forests, Ministry of Environment and Forests, Government of India, Mr. A.K. Ghosh, Director, Zoological Survey of India, Mr Ratho, IAS, Raj Bhavan, Mumbai, Members of the University Panel for the Post-Graduate studies in Botany and family members of the British High Commissioner.

From the international community of scientists, Dr. John Burton, UK, Dr. Simon Poucton,UK, Dr. Charles Woods, USA, Dr. Eric Finley, Australia, Mr. Gunnar Steidel, Germany and several others who had come during the international seminar visited the collections.

The Collections were visited in groups by several school students and under-graduate as well as post-graduate students from various colleges.

Identification

Photographs and specimens of plants and animals (mammals, birds, reptiles, amphibians and insects) received were identified and relevant information was given.

Additions

Br. Navarro's collection of mammal and bird specimen from St. Xavier's School was registered and added to the Society's collections. 75 skulls and jaw bones of blackbuck were received from the Grassland Project. 212 specimen of butterflies from Mr. Roger Ashton's collection were identified and added to the collections.

A total of 1091 plant specimens were identified, registered, the data entered in the computer and the specimens added to the herbarium this year. Out of this 77 specimens were from Neyveli Lignite Corporation, Madras, 507 from Nandur-Madhameshwar, 101 from Dahod, Gujarat, 45 from Karera, Madhya Pradesh, 20 from Western Ghats, Maharashtra, 390 from Bharatpur and 28 from Maharashtra. Herbarium sheets for 315 specimen were prepared.

Computerisation

Computerisation of the bird collection data began in February and upto March, 6000 entries were made. A 'Dictionary of Indian Mammals' was made for its use in computer application. Bird specimens are being catalogued and at present Part 38 (sparrows) of the Catalogue is being processed.

Surveys

A preliminary survey to study birds on Karanja was conducted and a report was submitted. Similarly, a survey was done to study the nesting of terns and swifts. As part of an EIA survey of Poshir Dam area, a survey was conducted for plants, butterflies and birds and similar survey was done in Parsik Hill area in Thane district for NOCIL.

The second phase of the status survey of the flora and fauna of Rajbhavan was undertaken and the final report has been submitted.

A week long survey was carried out at Kolhapur, Satara and Ratnagiri to determine the distribution and natural habitat of genus *Ceropegia* (Family: Asclepiadaceae) in Western Ghats, Maharashtra.

As part of the EIA project, a 15 day floristic survey of Neyveli Lignite Corporation, Tamil Nadu was carried out. Report on the Vegetation Analysis of the complete data with checklist of 241 plant species recorded in that area has been submitted.

Seminars and Workshops

The Curator attended a workshop for NGOs at NITIE and another on **Management and Promotional Policy for CEC and Volunteer Management**.

The Curator at the instance of the University of Bombay gave a series of lectures on Taxonomy of Insects (Paper I) for M.Sc. (Final) for entomology students.

The collection staff also assisted in conducting activities of the Sálim Ali Centenary Programme.

RESEARCH

During this year, BNHS had 7 major and minor research programmes.

Bird Hazard Research Cell

Funded by Aeronautics Research and Development Board, Ministry of Defence, Government of India. The Cell continued to provide consultancy service to aerodrome officials and identification of bird strike remnants received. Feather samples from the specimen in the research collection were taken for making slides for microscopic examination and comparison. At the request of aviation authorities, surveys were conducted at Bombay, Calcutta and Delhi airports.

Developing Electrophoretic Technique for Identification of Bird and Bat Aircraft Strike Remnants

A Vertical Gel Apparatus was purchased. The procedure for digestion of keratin in feathers was standardised. Procedures for electrophoresis and for staining the keratin proteins were standardised. The banding pattern for Black Kite *Milvus migrans* is being standardized.

Grassland Ecology Project

This project was funded by the U.S. Fish and Wildlife Service through the Ministry of Environment and Forests, Government of India. Field work on this project was concluded. Draft final technical report was prepared and sent to experts for comments.

Elephant Ecology and Elephant Radio Telemetry Studies

A combined final technical report of Elephant Ecology Project (1987-1992), and Radio Telemetry Project (1991-1994) was published.

Jerdon's Courser Project

Funded by the Ministry of Environment and Forests, Government of India, field work on this project was concluded. A final draft of the technical report has been prepared.

Ecology of Hill Streams of Western Ghats with special reference to fish community (Hill Stream Fish Project)

Funded by U.S. Fish and Wildlife Service through Ministry of Environment and Forests, Government of India, field sites were identified and permission from the Forest Department obtained. USFWS advisor to the project, Dr. Neil Armantrout visited proposed work sites. Surveys were carried out to collect fish specimen from various rivers of Southern Western Ghats in Kerala.

Development of Public Awareness at Pt. Calimere

Funded by Asian Wetland Bureau, Malaysia. The Project laid emphasis on baseline survey of villages around Pt. Calimere Wildlife and Bird Sanctuary on socio-economic status, educational level, cattle holding, life styles, dependence on natural resources and man-wildlife conflict. Awareness programme was targeted at villagers, school children, NGO's and tourists. Media of communication was through public meetings, video/films, slide shows, pamphlets and conducting essay, quiz and oratorial competitions for school children. Data collected over a 12 months period is compiled into the draft report.

ENVIRONMENTAL IMPACT ASSESSMENT CELL

The EIA Cell was set up two years ago at the BNHS with the intention to carry out EIA projects for project proponents. In India, EIA studies are linked to statutory clearances and the EIA Cell has, through meetings, correspondence with Department of Environment, Maharashtra Pollution Control Board, Industrial Associations and other EIA Agencies thus far succeeded in spreading the word to these and other peripheral agencies that we have now entered into this field.

The EIA Cell in the current financial year has been successful in acquiring five assignments of which two have been major EIA projects. Also, it may be necessary to add that we refused to undertake a major EIA project for INDAL (Project outlay: 10 lakhs) for their mines at Radhanagari.

EIA Cell has acquired and conducted the following studies:

1. Environmental Impact Assessment study for proposed Pumped Storage Hydro-electric Scheme at Hevale. Client: Irrigation Department (GOM) with JICA, Japan (1995-ongoing).
2. Rapid Ecological Assessment of Parsik Hills afforested area with respect to Avifauna and Butterflies, Client: NOCIL Petrochemicals Division, Thane (1995).
3. Rapid Environmental Assessment study of proposed Cement Plant and Mining Operations at Kutch District, Gujarat, Client: M/s Sanghi Cements Ltd., Andhra Pradesh, (1995).
4. Rapid Ecological assessment of proposed Poshir Dam Area in Thane District. Client: Center for Development Studies, Pune, (1995).
5. Rapid Survey of proposed Mining operations at Radhanagari WLS, Kolhapur. Client: INDAL, Kolhapur (1995).

Also, the laboratory has carried out physico-chemical analytical studies for a couple of clients, in addition to BNHS members/students at the rates prepared by the EIA Scientist and ratified by the Research Sub-Committee. The ongoing EIA project awarded by the Irrigation Department, Government of Maharashtra also includes a physico-chemical analysis component.

Symposia, seminars and workshops attended by the EIA Scientist

1. Training programme on EIA Practice, organised by British Council Division, Lonavala, April 1995.
2. Brainstorming Workshop on Action Plans on EIA, sponsored by UNEP, MoEF, organised by CESE, IIT, Bombay, May 1995.

3. Seminar on Recommendations of the WS Atkins study for a Comprehensive Transportation Plan for BMR, organised by BMRDA, Bombay, October 1995.
4. Workshop on "Utilisation of Coastal Environmental Maps", organised by Maharashtra Remote Sensing Applications Centre, VRCE, Nagpur, October 1995.
5. National Seminar on Environmental Economics and Urban Policy organised by IGIDR, Bombay, November, 1995.
6. International Conference on "Technologies for Environment Protection and Water Management", organised jointly by BCCI, ASSOCHEM, IMC,Bombay, November 1995. *Paper contributed*: Environmental Impact Assessment — An Ecological Perspective.
7. International Conference on Environmental Planning & Management, organised by VRCE, Nagpur, February, 1996.

SÁLIM ALI NATURE CONSERVATION FUND SUB-COMMITTEE

Chairman	Dr. P.R. Saraiya (Vice President)
Members	Mrs. D.S. Variava (Vice President)
	Mr. J.C. Daniel
Convenor	Mr. S. Asad Akhtar (Conservation Officer)

This year the conservation of Powai lake was prioritised. A public meeting was organised at IIT Powai to address the numerous problems confronting the lake. Following meetings at the BMC headquarters to take stock of the environmental problems facing the lake and suggest to corrective measures, the lake has now been brought under the **National Lake Conservation Plan**.

A survey was carried out in the Ghansoli Hills, Thane-Belapur Road, with a view to strengthen a proposal for a wildlife sanctuary in the area.

A field survey was undertaken of the Sharavathy valley Tail race Hydro Electric Project, Karnatakawas undertaken, to assess the impact of the dam on the valley. A meeting was organised at the BNHS in support of Sunderlal Bahuguna, who is leading an agitation against the Tehri dam project.

A follow up was also maintained vis a vis the conservation of the Narayan Sarovar Chinkara Sanctuary. BNHS members based in Gujarat were approached to suggest ways to tackle the issue. Report regarding Marine chemical industries in the Great Rann of Kutch was also investigated and a field survey carried out.

As part of the Tiger crisis cell at the BNHS, letters were addressed to the Chief Minister of Maharashtra, strongly advising the Govt. of Maharashtra to reconsider its decision to denotify the Melghat Tiger reserve. Contacts were also maintained with BNHS members and other NGOs, like the Ranthambore Foundation of Tiger Link to coordinate measures to save the Tiger. The spate of Tiger poaching reported from Madhya Pradesh was also brought to the notice of the MoEF. Regular meetings of the 'Tiger Link' were also organised at the BNHS.

Members were also advised to write to appropriate authorities regarding the denotification threats to the Bhimashankar and Koyna sanctuaries. Besides the proposal to denotify the Harishchandragad - Kalsubai Wildlife Sanctuary and the Bhigwan Sanctuary was also investigated.

A meeting was of the Armed Forces Cell was organised, in which serving officers from different wings of the armed forces took part. Environmental awareness workshops were planned and the necessary syllabus worked out.

Conservation issues in Orissa viz. denotification of the Bhitarkanika wildlife sanctuary and mining activities in the Upper Indravathy catchment area were addressed and a survey of these areas was also planned. The local NGOs and BNHS members were also approached to get a proper feedback. Controversial mining projects in the North Karanpura valley, Bihar were also investigated.

The issue of Elephant conservation in Meghalaya was investigated and followed up with letters to the Principal CCF and other officials in the Ministry of Environment and Forests, to reconsider the decision to locate a cement plant and mines on the periphery of the Balpakram National Park, which will disrupt the migratory route of the Elephants in the area. Letters were also written to the Chief Minister of Assam and the Environment minister to check the encroachments in the Laokhowa Sanctuary, Assam.

A policy paper on conservation issues was prepared and circulated to BNHS members and other concerned citizens. A meeting was subsequently organised to assess the general opinion of BNHS members vis a vis these issues. As an outcome of this meeting it was decided to hold monthly meetings with BNHS members on conservation issues. During one such interaction it was decided to survey the Pune-Lonavla Lake district area to assess the impact of urbanisation in the catchment areas of Pune's lakes. The survey was carried out in collaboration with BEAG and a BNHS member.

The Conservation Officer attended a workshop in Pune, organised by ECONET, to take stock of the Amendments to the Wildlife Protection Act (1972) and the proposed Bio Diversity Conservation Act.

A campaign to put Environmental issues on the agenda of National political parties was initiated. Efforts were made to set up an Enviro Legal cell at the BNHS and discussions were held with experts to work out the details of such a cell.

PUBLIC RELATIONS

Traditionally, BNHS has always maintained a low profile regarding publicity of its activities. However, with the changing times it was found essential to project the Society's image in the best possible manner so as provide information on the Society's activities. This was very useful for establishing our brand name, especially for marketing our products and approaching potential donors.

This year the BNHS received an exceptionally good press coverage of almost all activities, especially for those events held under the Sálim Ali Birth Centenary Programme and also for other activities like Public Meetings on Tiger Link, Powai Lake, Chipko and Armed Forces Cell besides the regular members' programmes held at Hornbill House. From time to time, press interviews were arranged for the Director, Curator, other scientists and members regarding projects, Sálim Ali Centenary programmes and other activities of the Society.

Both radio and television too gave adequate coverage for BNHS activities. BNHS Memorandum of Understanding with ZEE Television was extended for the display of BNHS products during their environmental programme **Hum Zameen**.

The much needed coloured brochure giving information at a glance on the BNHS was designed in-house and 10,000 copies were printed.

As part of the goodwill products programme, new designs for BNHS T-shirts and caps were developed. To market these products, direct mail order catalogue was advertised in the **Hornbill**. The response being very encouraging, repeat purchase orders were placed.

REPORT OF ACTIVITIES OF DR SÁLIM ALI BIRTH CENTENARY YEAR

The Centenary Celebration activities started in October 1994 when the Director, Dr Jay S. Samant asked the Curator to submit the tentative programme which could be arranged during the Birth Centenary Year of Dr Sálim Ali. Accordingly the Curator submitted a list of activities to be carried out during the year which was discussed in the Office Bearers Meeting and finalised. A small Working Group including Director, Dr Jay S Samant, Curator, Mr N Chaturvedi and PRO, Mr Isaac Kehimkar was formed to initiate various activities. Subsequently in August 1995 it was decided that the whole Executive Committee (EC) would function as the Sálim Ali Birth Centenary Committee. Under the overall guidance of the President and the members of the EC following programmes were arranged :

1. On 11th November 1995 the Sálim Ali Birth Centenary Year was officially launched by the Mayor of Mumbai, Shri R T Kadam. On this occasion the updated 2nd edition of a **Pictorial Guide to the Birds of Indian Subcontinent** was released by the Mayor.
2. On 12th November 1995 the **Sálim Ali National Bird Count** was arranged all over India. In Mumbai the Bird Count was conducted at the Sanjay Gandhi National Park when the Principal Chief Conservator of Forests, Shri A R Raddi was the Chief Guest and Mr David Elcome from the RSPB, UK was the Guest of Honour. Several forest officers including Conservator of Forests, Shri A K Nigam, Park Manager, Shri A R Bharati and members of the EC, i.e. Mr Humayun Abdulali, Dr R Reuben, Mr M R Almeida, Mr Sunjoy Monga, Dr A M Bhagwat and Dr Jay S Samant, students and reporters from various Newspapers had participated. The programme was covered by the Zee TV in 'Hum Zameen'. This activity was coordinated by the Conservation Officer, Mr Asad Akhtar.
3. The **Rare Book Exhibition** was organised from 15-24 December 1995. The Exhibition was inaugurated by the Maharao Shri Pragmulji Sawai Bahadur of Kutch on 15 December at 3.30 p.m. On this occasion a set of 4 bird prints were released by the Maharani Preetidevi. There was excellent response to the Exhibition. Besides the rare books, photographs of Dr Sálim Ali in action were also displayed. The Exhibition was organised under the overall guidance of Drs Ashok Kothari, Chairman, Library Sub-Committee and B F Chhapgar, EC Member.
4. The **Rangoli of Birds**, an Exhibition was organised from 22-30 January 1996. It was inaugurated by Shri Govind Swaroop on 22 January 5.00 PM. This was possible because of the members of the Rangavali Kala Darshan. Being a unique medium to exhibit birds, the Exhibition had excellent response from the members, public and press.
5. The Sálim Ali **International Seminar on Conservation of Avifauna of Wetlands and Grasslands** was organised from 12-15 February 1996 at the Indira Gandhi Institute of Developmental Research (IGIDR). The Seminar was attended by several international and national scientists, ornithologists and naturalists. 90 papers were presented during the Seminar and many resolutions were passed on the concluding day. The Seminar was followed by a post-seminar tour to the Jayakwadi, one of the Ramsar sites. The Seminar was inaugurated by Shri Mohan Dharia, Ex-Deputy Chairman, Planning Commission and Dr M S Swaminathan delivered the key-note address on "Building a National Ecological Security System". During the Seminar a special issue of "HORNBILL" dedicated to Dr Sálim Ali, a book on "CRANES" by Mr Prakash Gole and the

book on "ORNITHO-BOTANY OF BAYA" by Mr Satish Kumar Sharma, Range Forest Officer, Rajasthan were released. A Week with Elephants — Proceedings of the BNHS Seminar on Asian Elephant was also released. Considering the limited resources the Seminar was a grand success. The work of bringing out Proceedings of the Seminar is in progress.

6. Dr Sálim Ali Birth Centenary **National Painting Competition** was organised on 25 February 1996 for the children of various age groups. The programme was conducted at various centres all over India with active participation of our members. Prizes were given to the winners on 5 June 1996, World Environment Day, by the Chief Guest, Mr S P Godrej. On this occasion an Exhibition, "Himalayan Vision" was also arranged with the assistance of the British Council Division.
7. The Sálim Ali Centenary **Nature Photography Exhibition/Competition** was held during May-June 1996. On 20 June the Prize Distribution Function and the Exhibition of selected Nature Photographs was organised. The prizes were given by the Chief Guest, Vice Adm. Vishnu Bhagwat, FOC In-Chief, Western Naval Command. The prizes were sponsored by Shri Ajit Kerkar, Chairman, Indian Hotels Co Ltd. The Exhibition and Competition were arranged under the Chairmanship of Mr Adhik Shirodkar and with assistance of Mr Bodhe and other members. Mr Isaac Kehimkar, PRO was the Convenor.
8. The revised and enlarged centenary edition of the **Book of Indian Birds** was released on 8 July 1996 at New Delhi by the Minister of Environment and Forests, Capt. J N P Nishad, where Mr S C Dey, Additional Inspector General of Forests was also present. The function was also organised at the Hornbill House, Mumbai to release this book, which was released by Mr S P Godrej.
9. An **Exhibition of Birds in Paper Sculptures** by Mr Hemkant Gupte was organised at the Hornbill House from 2 September onwards. The Exhibition was inaugurated by Mr Jaywant Pathare, a renowned Cinematographer. The exhibition got a wide coverage and was appreciated by all.
10. Sálim Ali Centenary **Bird Stamp Exhibition** was organised from 17 September onwards. The Exhibition was inaugurated by Mr R Narasimhan, Chief Post Master General, Maharashtra. Many members exhibited their stamp collection during the Exhibition.
11. **A Tribute to Nature**, a mimesis in sand stone in honour of late Dr Sálim Ali was presented by Ms Varashree Narayan. The Exhibition was inaugurated by Mr J W Edmundson, First Secretary (Cultural Affairs), British Council Division, on 24 October, 1996.
13. **Release of Commemorative Postal Stamp** in honour of Dr Sálim Ali on 12 November 1996. A set of stamps alongwith First Day Cover with special post cancellation was released by the Governor of Maharashtra, Dr P C Alexander when Mrs Ackamma Alexander was also present. The Chief Post Master General, Maharashtra Circle, Mr Aggarwal presented the stamps to the Chief Guest. The Chief Guest also visited the Collections.
14. A special Book, **Sálim Ali's India**, was brought out as a part of the Centenary Programme and released on 2.12.1996 by Mr S P Godrej. The function was held at the Godrej Bhawan. The book is edited by Drs Ashok Kothari and B F Chhapger. The book got wide publicity through Newspapers and is a collector's item.

The programmes proposed for the Centenary Year and on which final action has to be taken are as follows :

(A) Sálim Ali Centenary Internaional Award and Sálim Ali Memorial Lecture: The name of the Awardee has been finalised and approved by the EC. Accordingly the recipient of the Award for the year 1996-97 is Mr Zafar Futehally. We have yet to inform him and also to request him to deliver the Sálim Ali Memorial Lecture at Mumbai. It is proposed to have this activity either in January/ February 1997.

(B) Sálim Ali Naturalist/Young Biologist Award: While thresponse to the Sálim Ali Young Biologist Award was disappointing, there was a good response to the Sálim Ali Naturalist Award. A meeting constituted for these awards will meet in first/second week of January 1997.

(C) A special issue of the Journal: September-December 1997 issue of the Journal will be brought out as a special issue of Journal, dedicated to Dr Salim Ali and will have invited articles.

Acknowledgement

I am thankful to the overall guidance and encouragement received from the President, Shri B G Deshmukh. I am also thankful to the Office Bearers and members of the EC under whose aegis these programmes were conducted successfully. The Centenary Photographic Exhibition was possible due to active support from the members, especially Mr Adhik Shirodkar. The Rare Book Exhibition and the book, "Sálim Ali's India" were possible due to active work of Drs Ashok Kothari and B F Chhapgar. The successful completion of all these activities were possible due to active support of the BNHS staff, especially the PRO, Mr Isaac Kehimkar who worked in coordination with the Organising Secretary.

VISITORS

Shri R T Kadam, Mayor of Mumbai, Shri Govind Swaroop, IAS, Secretary,Cultural Affairs, Government of Maharashtra, Mr. M.F. Ahemed, IG Forests, Ministry of Environment and Forests, Government of India, Mr. A.K. Ghosh, Director, Zoological Survey of India, Mr. Ratho, IAS, Raj Bhavan, Mumbai, Members of the University Panel for the Post-Graduate studies in Botany and family members of the British High Commissioner.

From the international community of scientists, Dr. John Burton, UK, Dr. Simon Poucton,UK, Dr. Charles Woods, USA, Dr. Eric Finley, Australia, Mr. Gunnar Steidel, Germany and several others who had come during the international seminar visited the Collections.

DONATIONS AND GRANTS

ACC	100,000.00
Ms Thrity Badami	1,001.00
Mr Ruchir Bansal	1,000.00
Mr T R Bhagwat & Associates	1,001.00
Mr T R Bhagwat	1,001.00
Brihan Mumbai Municipal Corporation(BMC)	5,00,000.00
Essan Investments Ltd.	25,000.00
Mr Kamlesh Gandhi	1,000.00
Mr S S Kamat	1,000.00
Ms Meeta (Ex IMS)	2585.00
Ms Rati Mehenti	1,000.00
Ms Devyani J Mehta	2,000.00
Mr Indravan Rambai Mehta	2,000.00
Mehta Scientific Education & Research Trust	25,000.00
National Plastic Industries	3,000.00
Network India Ltd.	4,000.00
Seth P Thakurdas & Divaliba Charitable Trust	1,20,000.00
Shree Karni Enterprises	5,000.00
Mr D I Solanki, Maharaja of Vansda	10,000.00
Tata Hydro Electric Power Supply Co. Ltd./ Tata Power Co. Ltd./ Andhra Valley Power Supply Co. Ltd.	500,000.00
M/s Vijay Sales	2,000.00
Dr J A Woolcock	1,422.00
Mr Kantilal C Zaveri	2,000.00
Mr Sunil Zaveri	10,000.00

DONATIONS FOR PUBLICATION OF *SALIM ALI'S INDIA*

M/s. B Arunkumar & Co.,	20,000
M/s. Bhansali & Co.	5,000
Shri Brijnand Ch. Trust	10,000
M/s. Diwaliben Mohanlal Ch. Trust	20,000
M/s. Everest Gems	20,000
M/s. The Gokak Mills Ch. Trust	2,000
M/s. Industrial Manufacturers	10,000
M/s. P D Kothari & Co.	20,000
M/s. Lakhi Trust	20,000
M/s. Mahamaya Investment Ltd	800
M/s. Mangalaya Trading Investment	1,000
M/s. D Navinchandra & Co	20,000
M/s. F K S Nicholson	20,000
M/s. Omega Shipping Pvt Ltd	20,000
M/s. Sayaji Industries Ltd.	5,000
M/s. Shipla Shah	20,000
M/s. W W Shipping Ag. Pvt Ltd	20,000
M/s. Su-raj Diamond Ind.	20,000
M/s. Vijay Star	40,000
M/s. Zandu Pharmaceuticals	3,000

WELL-WISHERS

M/s Walker Packaging
Mr Ashish Vashisht
Mr De Preozel, France
Mr Orhant Georges, France
Hirdwani Trust
Mrs. Akila Vaidyanathan
Ms Shalini Susheel
Mr S B Motivala
Mr V K Suresh
M/s. Piramal Trust

ACKNOWLEDGEMENT

We are grateful to the following persons for their assistance in various activities of the Society:

Mr Sudheer Agashe
Dr Sanjay Bhagwat
Mr M R Almeida
Dr B F Chhapgar
Mr J C Daniel
Dr B Dasgupta
Mrs V B Deshmukh
Capt. Subhash Deshpande
Mr Mihir Deware
Ms Mehera Dubhash
Mr Shyam Ghate
Mr Arun Joshi
Mr Manoj Karkhanis
Mr K V Kini
Mr Ashok Kothari
Dr C S Lattoo
Maj. M Maskar
Mr Atul Mathur
Mr Sunjoy Monga
Mr A K Nigam
Mr V K Paralkar
Mr Ulhas Rane
Dr Rajendra Shinde
Mr Vilas Shingre
Ms Neeta Sukhtankar

The Executive Committee acknowledges with thanks the assistance given to the BNHS by the Ministry of Environment, Forests and Wildlife of the Government of India, Ministry of Defence of the Government of India, the United States Fish & Wildlife Service, Overseas Development Administration, UK, British Council Division, Mumbai, the Government of Maharashtra, and the Charity Commissioner, Mumbai. It also thanks the members and staff of the BNHS for their unstinted support in the various activities of the Society.

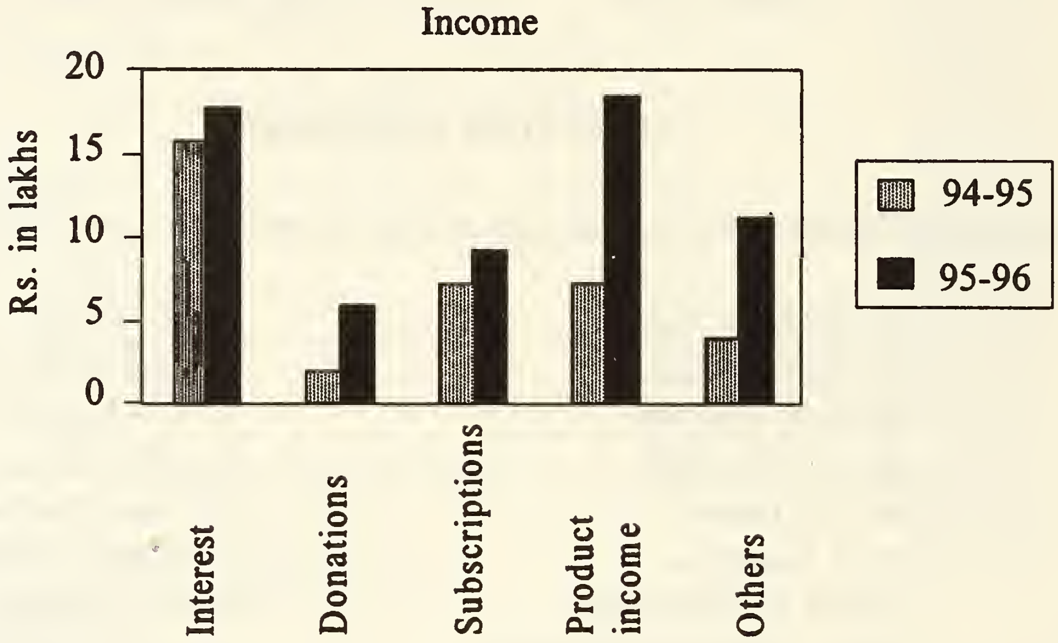
Dr Ashok Bhagwat
Honorary Secretary

HONORARY TREASURER'S REPORT ON THE ACCOUNTS FOR THE YEAR ENDED ON 31st MARCH 1996

I have the pleasure to report on the accounts for the year ended 31st March 1996.

Income

The income of the Society witnessed a significant growth over the previous year except in the area of Grants.



The contributions from Products and the EIA cell are creditable.

Grants

The Society received a total of Rs.72.49 lakhs as grants this year. Rs.51.81 lakhs was spent on respective projects and Rs.45.23 on creation of fixed assets. The most significant among these was the Conservation Education Centre funded by the ODA. The overdue grants from the Government of India for airconditioning of the reference collection is still outstanding, although some amount was received during this year. Intensive efforts are currently being made to recover the same. An amount of Rs.1.82 lakhs was written off to bring the books of account in line with the actual claims made. No progress could be made in recovery of Rs. 1 lakh from the Government of India in respect of the grant for Nature Conservation Course for Indian Army.

Surplus

The surplus of income over expenditure for the year is Rs.0.09 lakhs.

Investments

The long term Funds of the Society of Rs.278 lakhs are grossly under covered by the investments and fixed assets of Rs.224 lakhs. The situation needs to be corrected to secure long term solvency of the Society.

Funds and Endowments

The income of the Funds and endowments of the Society remained unspent. Efforts need to be made to spend these resources for the objects of the Funds and endowments.

Vinod Haritwal
Honorary Treasurer

11th January, 1997

AUDITORS' REPORT

BOMBAY NATURAL HISTORY SOCIETY

(REGISTERED NO.F-244-BOM.)

We have audited the attached Balance Sheet of the Society as at March 31, 1996 and also the annexed Income and Expenditure account for the year ended on that date and report that in our opinion and to the best of our information and according to the explanation given to us:

(a) the accounts are maintained regularly and in accordance with the provisions of the Bombay Public Trust Act, 1950. subject to the observations that as per past practice separate Receipts & Payment account has been drawn for the Nature Education Scheme and the same has not been incorporated in the accounts of the Society. We observe that as per the accounts so drawn up a sum of Rs.30,954.75 is considered to be due to the Society as at the date of the Balance Sheet. We have been given to understand that on settlement of the claim for arrears of grant from the Government the account would be adjusted.

(b) the receipts and disbursements have been properly and correctly shown in the accounts, subject to the observations that as per the accounting practice adopted grants from State Government and other sponsoring organisations are being accounted in anticipation of actual receipt of sanction letters based on the claims preferred/to be preferred. We observe that following amounts so accounted in the earlier years had remained unrealised till the date of the Balance Sheet,

(i)	Central Government (Ministry of Environment and Forest) Grant for Air conditioning of Reference Collection Room & Library	7,35,482.95
(ii)	Government of India (Ministry of Environment & Forests) Grant for Nature Conservation Courses for Army	1,00,000.00
(iii)	Central Govt. (Dept. of space) Ecological Investigation of Avian Community of Sriharikota.	50,655.00

We understand that since then the aforesaid amount of Rs.1 lac has been realised. In the context of the grant for central airconditioning system, we observe that during the year under report a sum of Rs.2,76,115 has been received by the Society against the claim of Rs.4,84,439.80 for the period upto 01-07-1993. On review of the position of the claim accounted in the earlier years in the wake of the amount of the grant realised a sum of Rs.1,82,373.42 has been written back considering it to be not admissible. The Society has made representation for claiming the balance amount. We further observe that of the expenditure incurred during the year towards airconditioning of collection room and library Rs.3,64,712.35 has been considered to be recoverable by way of grant from the Government. Thus the total amount considered recoverable from the Government on this account as at the date of Balance Sheet amounts to Rs.11,00,195.30.

We are not in a position to offer any comments about the realisability of the aforesaid outstanding dues. We reiterate our views that the income of such nature should be recognised as income when there is no uncertainty about its realisation,

c) the cash balance and the vouchers in the custody of the accountant on the date of audit were in agreement with the books of account

(d) the books, deed, accounts, vouchers and/or other documents or records required by us were produced to us,

(e) the register of movables and immovable properties has been maintained; however the change reports have remained to be communicated to the Regional Office. In the context of equipments and other such items of capital nature acquired out of various grants and other project funds, we observe that initially the cost of such equipments etc. is charged to the relevant project accounts and on completion of the projects, the Society generally seeks the permission of the concerned sponsoring authorities to retain such assets, as are found to be useful for other projects and/or other purposes and on obtaining such approvals the necessary entries are passed in the books of amount of the Society to record the residual value of such items. While referring to the observations made in our report accompanying the statement of accounts for the year ended 31st March, 1994, we observe that the value of a jeep so retained has still not been brought into accounts. In the absence of adequate information it has not been possible for us to verify if the value of all the items allowed to be retained has been brought into accounts. We have however been given to understand that the property in the assets acquired and the construction work of the Conservation Education Centre being carried out vests in the Society and with a view to conform to the accounting treatment as laid down in the Accounting Standard AS 12 issued by the Institute of Chartered Accountants of India the disbursements in the nature of capital expenditure made from the amount of the grant received from the Government for the purpose since its inception has been brought into accounts. The corresponding amount has been shown as "deferred grant" in accordance with the guidelines laid down in the said AS 12 and on depreciation being reckoned on the relevant assets ever since the date of acquisition thereof the corresponding amount of Rs.9,77,308.70 has been transferred to the said deferred grant. We suggest that the change in the accounting treatment and the entries as recorded in the books of account in this respect may kindly be confirmed in the next meeting of the Executive Committee.

We also understand that the Society is holding a number of "medals" of different precious and semi-precious metallic contents which were awarded to late Dr.Sálim Ali and which under his Will have been obtained by the Society. The same we are informed are being held as commemorative souvenirs. The value thereof has not been brought into accounts as it is contended that the said souveirs being of aesthetic and sentimental value and commemorative in nature cannot be reduced to monetary value,

f) the Hon.Treasurer and the accountant appeared before us and furnished the information required by us,

(g) we are not aware of any property or funds of the Society having been applied for any objects or purposes other than the objects or purposes of the Society,

(h) the following amounts were outstanding for more than one year:

dues towards supplies & services	Rs. 68,703.45
loans to staff	Rs. 14,550.00
advances for expenses (for projects & other expenses: to employees (including ex employees) to others.	Rs. 54,935.35
other dues	Rs. 48,873.45
grants receivable	Rs. 8,86,137.95
suspense account	Rs. 1,570.25
income tax refundable	Rs. 79,181.00

In the context of the aforesaid outstanding of Rs.54,935.35 representing advances to the employees, we understand that it includes Rs.16,460/- from employees who are no longer in the employment of the Society. The same it is however stated is proposed to be adjusted against their retirement dues payable to them. The liability whereof has not been brought into accounts. Other dues include Rs.36,589.45 dues from various parties against the expenses incurred for and on their account. Some of these amounts are outstanding for more than three years. We are not in a position to comment on the realisability of the said dues. In the context of income tax refundable we observe that the assessment has been completed upto A.Y. 1994-95 & the above amount of Rs.79,181/- includes the amount of claim of Rs.7,560/- which could not be realised for want of the TDS Certificate. The said shortfall in the realisation of the claim has not been adjusted in the books of accounts. Subject to the observation in para (b) hereinabove no amount has been written off during the year. We have been assured that the outstanding balances are considered good and recoverable.

(i) during the year under report a sum of Rs.35,955/- has been spent on repairs to drive way of the Car park yard at Hornbill House. We have been informed that limited enquiries were floated for the purpose and based on the estimates obtained the work was awarded to one of the contractors. Besides we observe that during the year under report a sum of Rs.23,98,936.34 has been spent towards the construction of Conservation Education Centre at Goregaon (E) bringing the total outlay on the said construction work to Rs.56,34,918.34 till the date of the Balance Sheet. We are informed that a specific grant has been received for the purpose of the construction of the said Centre and other expenses relating thereto accordingly as referred to in para (e) herein above the amount spent on the construction work has been adjusted from the grant so received.

(j) we are not aware of any money of the Society having been invested in contravention of Sec. 35 of the Bombay Public Trust Act,1950.

(k) no alienation of the immovable property contrary to the provisions of Sec. 36 of the Bombay Public Trust Act, 1950 have come to our notice,

(l) we observe that expenses of Rs.60,56,077.83 in the aggregate having been considered to have been met out of the various funds and the grants corresponding amount has been transferred from the relevant accounts of the grants and the respective funds. We have relied on the information given to us and the authorisation of the Hon. Secretary and the Hon. Treasurer in regard to the said expenditure having been incurred for the specific objects for which the said grants and/or the funds have been received by the Society. While checking the statement of accounts in regard to the expenses incurred at various camps, we have relied on the authorisation by the Hon. Secretary and Hon. Treasurer as to the reasonableness of the expenses,

(ii) pending the final determination of the liability towards the claim of some of the local field workers, (whose services were engaged for one of the projects at Bharatpur) for reinstatement and other service benefits, which is being disputed by the Society. We are informed that the matter is pending before the Labour Court at Bharatpur and the Provident Fund authorities. An adhoc provision of Rs.194,060.70 made in the accounts in the earlier years for this purpose has been retained in the accounts,

(iii) the income from membership fee is being accounted on realisation basis. Hitherto the amount of entrance fees received from the members was being accounted as revenue income. Effective from the year under report the same has been treated as capital receipt and has been accordingly credited to Life Membership and Entrance Fees Fund account. Due to the said change in the accounting policy the surplus for the year is under stated by Rs.44,860. The bye-law of the Society does not specifically provide for such treatment in the accounts.

(iv) we have been given to understand that on physical verification of the fixed assets certain items were found to be lying with some members for research/study purpose. We suggest that proper records in this respect may be maintained and the year end confirmation be obtained from the borrowing members,

v) we observe that the Society is celebrating Dr. Sálim Ali Centenary and in this connection seminars and other functions are being organised and certain special publications are also in the process of being released. Since the centenary year is extending to the current financial year, the amount of donations and contributions received in connection with the celebration of the centenary and the expenses incurred have been carried forward to the next year. The net balance representing the excess of the collection over the expenses incurred till the date of the Balance Sheet amounting to Rs.5,39,166.40 has been accordingly carried forward to the next year.

(vi) we suggest that the following items of disbursements effected, appropriations made and administrative charges levied be confirmed and ratified at the next meeting of the Executive Committee.

A. Disbursement from:

		Rs.
1.	Sálim Ali Nature Conservation Fund	1,82,893.28
2.	Sálim Ali Memorial Fund.	13,310.00
3.	Staff Gratuity Fund	98,112.00
4.	Staff Welfare Fund	13,398.80
5.	ICICI Environment Research & Education Fund	1,87,500.06
6.	TISCO Conservation Education Reserach & Awareness Fund	2,80,000.00
7.	Elephant Telementry Project	8,000.00
8.	Ecology of Jerdon's Courser	47,654.41
9.	Dept. of Science & Technology	22,518.00
10.	Ministry of Environment & Forests Nature Conservation Course (Indian Army)	1,261.25

Grants from United States Department of Interior, Fish & Wildlife Service for (Revenue Expenditures)

		Rs.
1.	Ecology of Dry Grasslands	8,35,499.30
2.	Ministry of Defence ARDB for Project in Development of Electro-phorensis Tech. for identifying birds & bats, aircrafts strike remains	1,18,108.80
3.	Study of Conservation of Birds of Prey	40,038.18

Particulars emphasis upon Restoration of Endangered species.

		Rs.
1.	Hawk & Owl Trust Grassland Roosting Harriers	70,854.07
2.	Endangered Turtles of Pondichery	4,074.25
3.	Grant for Chilka Lake Project	12,688.89
4.	Neyveli Lignite Project	38,840.80
5.	Conservation Education Project	35,81,452.59
6.	Aeronautics Research & Development Board Grants	80,822.50
7.	Hill Stream Fish	1,95,552.60
8.	Asian Wetland Bureau	69,867.50
9.	Narayan Sarovar Project	54,545.55

For Capital Expenditure :

		Rs.
1.	Ministry of Defence ARDB for Project in Development of Electrophorensis Tech. for identifying birds and bats aircrafts strike remains	53,200.00
2.	Conservation Education Project	41,64,363.90
3.	Hill Stream Fish	3,05,179.82

B. Appropriations:

Staff Gratuity Fund	2,912.19
Staff Welfare Fund	50,000.00

C. Amount met out of funds for Expenses:

1.	For Nature Conservation	1,82,893.28
2.	For Gratuity Payment	98,112.00
3.	For Beautification of Dr. Sálim Ali Chowk	13,310.00
4.	For Staff Welfare Fund	13,398.80
5.	ICICI Environment Research & Education Fund	1,87,500.06
6.	TISCO Conservation Education Research & Awareness Fund	2,80,000.00

While on the subject, we observe that as at the end of the year the accounts relating to the following projects, which stand completed reflect the over run position as under:

Unadjusted Deficit on Project:

		Rs.
a.	Ministry of Defence (ARDB) for BHRC	37,278.54
b.	Smithsonian Institute, Washington, for Revision of the Handbook of the Birds of India & Pakistan	284.08
c.	Asian Wetland Bureau	6,286.50
d.	Hawk & Owl Trust	5,002.32

The above balances may be appropriately adjusted if the same be not likely to be recouped from further grant/donation. We are not in a position to. comment on its realisability,

vii) we observe that contribution to employees' provident fund (both the employees and the management contribution) continues to be deposited with the Trustees of a recognised provident fund established by the Society and governed by the rules framed for the purpose. There seems to have been certain amendments to the Employees Provident Fund and Miscellaneous Provisions Act, 1952 whereunder the Society may not only be liable to transfer the accumulated balance in the Employees' Provident fund account to the Provident Fund Commissioner Govt. Scheme, but also for the difference in the amount of contribution. The liability in this regard has not been determined.We suggest that proper legal opinion may be sought in this behalf and the needful may be done in the matter. We further observe that no provision has been made for the accrued liability for the leave encashment. As regards the liability for the further payment of gratuity to the employees, we observe that the society has obtained a policy from LIC under the Group Gratuity Scheme. The additional liability arising in the wake of the amendment to the payment of Gratuity Act enhancing the limit remains to be covered under the said policy, for which no provision has been considered in the accounts.

(viii) in the context of the foreign contribution by way of grant/donations etc. being received by the Society, we observe that the requisite return has been filed with the concerned authority in respect of certain specific grant that had been received by the Society. We suggest that the position in regard to the other amounts being received by the Society may be examined and necessary action may be taken to comply with the requirements of the provisions of the Foreign Contribution (Regulation) Act, 1976 and the rules framed thereunder,

(m) so far as it is ascertainable from the books of account and according to the information and explanation given to us by the Hon. Treasurer and the Hon. Secretary, there were no cases of irregular, illegal or improper expenditure or failure to recover the money or other properties belonging to the Society or loss or waste of money or other property of the Society subject to the observations made in para (h) hereinabove,

(n) provisions of Sec. 31-A of the Bombay Public Trust Act, 1950 and Rule 16-A of the rules framed thereunder have not been compiled with,

(o) the maximum and minimum number of Executive Committee members is maintained having regard to the provisions in the Rules and Regulations of the Society.

(p) there are no specific provisions in the Rules and Regulations of the Society regarding the holding of the meetings of the Executive Committee.

(q) the minute book recording the proceedings of the meetings is maintained,

(r) no member of the Executive Committee has any interest in the investment of the Society,

(s) no member of the Executive Committee is a debtor or creditor of the Society subject to the observations that a sum of Rs.27,697.50 given as an advance to one of the members for expenses has been outstanding as at the date of the Balance sheet.

(t) there were no irregularities pointed out in our last report dt.30th Sept. 1995, accompanying the statement of accounts for the year ended 31st March, 1995 except the observations made in paras (b), (e), (h), (L) (v) and (l) (vii) the observations whereof have been reiterated hereinabove to the extent the issues still remain outstanding.

PLACE : MUMBAI
DATED : 31-01-1997

HABIB & COMPANY
CHARTERED ACCOUNTANTS

BOMBAY NATURAL HISTORY SOCIETY
BOMBAY PUBLIC TRUST ACT, 1950 : REGISTRATION NO. F-244 (BOM)
SCHEDULE VIII VIDE RULE 17(1)
BALANCE SHEET FOR THE YEAR ENDED 31ST MARCH 1996

Previous year 1994-95 Rs.	FUNDS AND LIABILITIES	Rs.	Current Year 1995-96 Rs.
	LIFE MEMBERSHIP & ENTRANCE FEES FUND		
19,90,515.12	Balance as per Last Balance Sheet	21,91,215.12	
2,00,700.00	Add: Received during the year	2,50,010.00	
21,91,215.12			24,41,225.12
	CORPORATE LIFE MEMBERSHIP FUND		
2,25,742.31	Balance as per last Balance Sheet		2,25,742.31
	VICE PATRON FUND		
42,769.00	Balance as per last Balance Sheet		42,769.00
	CORPUS FUNDS		
25,36,687.97	As Per Schedule "A"		25,36,687.97
	OTHER FUNDS		
1,28,49,257.61	As Per Schedule "B"		1,34,21,566.87
	DR. SÁLIM ALI CENTENARY CELEBRATION FUND		
	Collection Made During The Year		
Nil	Grant from Govt. of India, MoEF	2,00,000.00	
Nil	Donation	2,95,120.00	
Nil	Contribution From Delegates For Seminar	1,96,396.00	
Nil	Donation For Sálim Ali's India Publication	3,14,800.00	
Nil	Other Income	12,691.00	
		10,19,007.00	
Nil	Less: Expenses incurred till date	4,79,840.60	
Nil			5,39,166.40
	DEFERRED GRANTS		
Nil	Amount Of Grants Utilised Towards Capital Expenditure	97,73,455.54	
1,78,45,672.01			2,89,80,613.21

Previous year 1994-95 Rs.	PROPERTIES AND ASSETS	Rs.	Current Year 1995-96 Rs.
	INVESTMENTS (AT COST)		
58,66,281.50	As per Schedule "F"		50,21,644.00
	FIXED DEPOSITS WITH		
15,00,000.00	Housing Development Corporation Ltd.	Nil	
5,00,000.00	Industrial Credit & Invest Corp. of India	10,00,000.00	
5,00,000.00	Industrial Development Bank Of India	5,00,000.00	
20,00,000.00	Indian Oil Corporation (Earmarked specifically against TISCO Conservation Edn. & Awareness Fund)	20,00,000.00	
10,00,000.00	Steel Authority of India	10,00,000.00	
Nil	Standard Chartered Bank (earmarked against Dr Sálim Ali's India publication)	5,00,000.00	
Nil	Indian Telephone Industries	10,00,000.00	
Nil	ANZ Grindlays Bank (earmarked against Dr Sálim Ali International Award)	1,00,000.00	
55,00,000.00			61,00,000.00
	FIXED ASSETS		
28,82,402.09	(As per Schedule "E")		1,13,18,578.82
	LOANS		
1,43,625.00	(Unsecured Considered Good) To Employees		1,04,650.00
	ADVANCES		
60,636.90	(Unsecured Considered Good) To Employees (For Project & Other Expenses)	1,03,373.40	
1,44,52,945.49			2,26,48,246.22

Previous year 1994-95 Rs.	FUNDS AND LIABILITIES	Rs.	Current Year 1995-96 Rs.	Previous year 1994-95 Rs.	PROPERTIES AND ASSETS	Rs.	Current Year 1995-96 Rs.
1,78,45,672.01	Brought over....		2,89,80,613.21	1,44,52,945.49	Brought over....		2,26,48,246.22
Nil	Less: Depreciation Till 31.3.95	6,70,353.80		2,00,064.89	To Others (For Project & Other Expenses)	44,157.50	
Nil				80,160.00	Against Journal Papers	1,36,814.67	
Nil	Less: Depreciation For The Year	4,88,791.90		800.00	Advance against salaries to employees	11,744.00	
Nil				4,500.00	Advance for rent	4,500.00	
	CURRENT LIABILITIES			93,623.00	Computer Maintenance	89,762.50	
60,90,115.92	For Unspent Grants as per Schedule "C"	33, 25,069.22		76,853.45	Other dues for travel & other exp.	87,697.45	
				Nil	Advance For Pictorial Guide	1,60,616.00	
3,61,851.32	For Expenses	4,16,991.17		Nil	For Sub-Station	10,000.00	
31,200.00	For Library Deposits	58,400.00		Nil	Sundry Debit Balances	76,121.67	
33,299.10	For Sundry Credit Balances	1,46,985.90		Nil	Dues From Nature Education Scheme	30,954.75	
30,256.11	For Advances for Publications and Products	30,256.11		4,56,001.34			6,52,368.54
65,46,722.45			39,77,702.40		**DEPOSITS**		
				77,831.00	BEST Undertaking	77,270.00	
	OTHER LIABILITIES			59,982.00	Mahanagar Telephone Nigam Ltd.	61,001.00	
815.00	Professional Tax	800.00		1,000.00	NCST for Electronic Mailing	1,000.00	
2,150.00	Employees Provident Fund	Nil		6,850.00	Gas Cylinder for Projects	6,850.00	
6,014.00	T.D.S.	3,936.00		Nil	Elec. Deposit for Projects	561.00	
35,801.00	L.I.C. Gratuity	Nil		2,500.00	For Vehicle Fuel Supply	2,500.00	
				401.80	For Franking Machine	6,772.95	
44,780.00			4,736.00	2,28,396.00	For Accommodation	2,25,396.00	
				50.00	For Burner	50.00	
	INCOME & EXPENDITURE ACCOUNT			90,000.00	Security Deposit (CEP)	1,05,000.00	
1,10,911.99	Balance as per last Balance Sheet	12,480.77		20,000.00	Tata Sumo Vehicle	Nil	
1,00,000.00	Less: Appropriation towards proposed Institute Fund	Nil		Nil	Cassette Deposit	200.00	
10,911.99		12,480.77		4,87,010.80			4,86,600.95
1,568.78	Add: Excess Of Income Over Expenditure During the Year	9,573.62			**STOCKS** As Per Inventories Valued and Certified by the Hon. Secretary		
12,480.77			22,054.39				
				7,29,831.55	BNHS Publications	6,92,141.36	
				34,405.93	Govt. Publications	31,171.53	
				2,05,577.00	Greeting Cards	8,18,977.50	
				11,300.00	BNHS T-Shirts	18,000.00	
				2,303.00	BNHS Mugs	1,739.00	
2,44,49,655.23	Carried over....		3,18,25,960.30	1,63,79,375.11			2,53,49,245.10

Previous year 1994-95 Rs.	FUNDS AND LIABILITIES	Rs.	Current Year 1995-96 Rs.	Previous year 1994-95 Rs.	PROPERTIES AND ASSETS	Rs.	Current Year 1995-96 Rs.
2,44,49,655.23	Brought over....		3,18,25,960.30	1,63,79,375.11	Brought over...		2,53,49,245.10
				5,539.00	BNHS Caps	4,600.00	
				Nil	Birds Poster	1,27,366.30	
				3,860.00	BNHS Bags	3,860.00	
				5,663.75	BNHS Stickers	5,663.75	
				15,062.75			1,41,490.05
					BOOKS UNDER PUBLICATION		
					(Expenses Incurred Till Date)		
				1,82,725.00	Book Of Indian Birds Reprints Ed.	2,80,857.00	
				63,444.60	Flora of Keoladeo National Park	63,444.60	
				2,46,169.60			3,44,301.60
					INCOME OUTSTANDING		
				2,50,149.67	Interest Accrued	2,68,937.30	
				6,38,651.75	For Publications	7,56,502.00	
				42,317.95	For Greeting Cards	1,00,516.55	
				1,46,422.50	For Calendars	51,188.03	
				Nil	For Birds Poster	13,557.00	
				447.00	For Xerox Charges	Nil	
				10,77,988.87			11,90,700.88
					GRANTS RECEIVABLE		
				11,93,971.37	From Govt. of India, Ministry of		
					Environment	11,00,195.30	
					& Forests (Reference Collection		
					Airconditioning expenses / expenditure		
					for the year Rs.7,64,126.93		
				Nil	From Govt. of Maharashtra (1995-96)	2,50,000.00	
				1,00,000.00	From Govt. of India, Ministry		
					of Environment	1,00,000.00	
					(Nature Conservation Course for		
					Indian Army		
				40,106.45	Royal Western India Turf Club Ltd.	Nil	
				50,655.00	Sriharikota (Project) Govt. Of India.	50,655.00	
				44,000.00	Jerdon's Coursers Project.		
					Govt. Of India	44,000.00	
2,44,49,655.23	Carried over....		3,18,25,960.30	1,91,47,329.15			2,85,70,587.93

Previous year 1994-95 Rs.	FUNDS AND LIABILITIES	Rs.	Current Year 1995-96 Rs.	Previous year 1994-95 Rs.	PROPERTIES AND ASSETS	Rs.	Current Year 1995-96 Rs.
				1,91,47,329.15	Brought over...		2,85,70,587.93
2,44,49,655.23	Brought over....		3,18,25,960.30	Nil	Ministry Of Defence. ARDB Project in Dev. Of Electrophorensis Tech. for Identifying Birds & Bats aircrafts strike remains	1,90,935.00	
				Nil	Aeronautics Research & Development Board	99,475.00	
				Nil			2,90,410.00
				79,181.00	**INCOME TAX (TDS)**		1,03,320.00
				51,64,508.31	**CASH AND BANK BALANCES** (As per Schedule 'D')		28,12,790.93
					UNADJUSTED DEFICIT ON PROJECTS		
				37,278.54	(a) Ministry of Defence (ARDB) for BHRC	37,278.54	
				21,074.15	(b) Elephant Telemetry Project	Nil	
				284.08	(c) Smithsonian Inst., Washington, for revision of the Handbook of Birds of India and Pakistan	284.08	
				Nil	(d) Asian Wetland Bureau	6,286.50	
				Nil	(e) Hawk & Owl Trust	5,002.32	
				58,636.77			48,851.44
2,44,49,655.23			3,18,25,960.30	2,44,49,655.23			3,18,25,960.30

BOMBAY NATURAL HISTORY SOCIETY

Sd/-
HONORARY SECRETARY

Sd/-
HONORARY TREASURER

AS PER OUR REPORT OF EVEN DATE

Sd/-
HABIB AND COMPANY
CHARTERED ACCOUNTANTS

Bombay
Dated: 31st January, 1997

BOMBAY NATURAL HISTORY SOCIETY
BOMBAY PUBLIC TRUST ACT, 1950
REGISTRATION NO. F-244 (BOM) SCHEDULE IX VIDE RULE 17(1)
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 1996

Previous year 1994-95 Rs.	EXPENDITURE	Rs.	Current Year 1995-96 Rs.	Previous year 1994-95 Rs.	INCOME	Rs.	Current Year 1995-96 Rs.
	EXPENDITURE IN RESPECT OF PROPERTIES				**INTEREST (RECEIVED & ACCRUED)**		
11,156.00	Municipal Taxes	11,156.00		110.00	On Goverment Securities	110.00	
285.00	Building Insurance	Nil		4,25,095.01	On Fixed Deposits	7,70,388.06	
9,49,886.55	Repairs and Maintenance	55,468.50		10,355.17	On Saving Accounts	9,887.65	
				80,000.00	On ICICI Bonds	80,000.00	
				48,000.00	On IDBI Bonds	48,000.00	
9,61,327.55			66,624.50	3,373.00	Interest on loan to staff	1,916.00	
	ESTABLISHMENT EXPENSES			5,66,933.18			9,10,301.71
5,91,333.00	Salaries of Reference Collection and Maintenance staff	6,31,075.00		10,93,845.01	Distn. of Income from UTI		9,77,988.06
17,16,473.60	Salaries to other staff	20,41,305.00					
27,345.00	Leave Travel Allowances	35,814.00			**DONATIONS (In cash or kind) For Specific Purposes:-**		
17,155.95	Reimbursement of Medical Expenses met out of staff welfare fund	13,398.80					
54,000.00	Compensation for staff accommodation	54,000.00		400.00	a) SANCF Corpus Fund	Nil	
9,264.00	Uniform and umbrellas to staff	2,070.00		1,00,000.00	b) Sálim Ali Memorial Fund	Nil	
2,130.00	Washing Allowances	3,630.00		Nil	c) Nature Enthusiast World	1,49,000.00	
88,388.00	Management's contribution to Provident Fund	93,960.00		600.00	d) Charles MaCann Vertebrate Zoology Fund	600.00	
75,600.00	Gratuity paid to staff	98,112.00		40,000.00	e) Hornbill printing	25,000.00	
37,069.00	Premium paid to BNHS Employees' Group Gratuity Scheme	37,437.37		1,23,005.65	f) General purposes	5,66,286.15	
				Nil	g) For Proposed Institute Fund	5,00,000.00	
17,083.25	Casual Labour	11,598.00		15,00,000.00	h) ICICI Environmental Research & Edn. Fund	Nil	
27,852.60	Meeting expenses	60,234.10					
70,842.95	Postage Expenses	65,789.75		20,00,000.00	i) TISCO - Conservation Education Research & Awareness Fund	Nil	
47,421.75	Printing & Stationery	1,05,032.30					
9,350.50	Advertisements	2,413.75		Nil	j) Chennas Fund	5,000.00	
82,403.40	Telephone Expenses	1,31,072.50					
74,771.80	Electricity Expenses	1,12,779.00		37,64,005.65			12,45,886.15
33,137.20	Travelling Expenses	58,724.60					
24,294.85	Conveyance Expenses	42,314.75			**GRANTS**		
1,07,831.40	Vehicle Maintenance	69,877.70			i) From Govt. of Maharashtra for 1995-96		
3,699.55	Bank Charges (Net)	7,116.50					
31,17,447.80			36,77,755.12	2,08,811.75	a) For Collections		2,08,811.75
40,78,775.35			37,44,379.62	56,33,595.59			33,42,987.67

Previous year 1994-95 Rs.	EXPENDITURE	Rs.	Current Year 1995-96 Rs.
40,78,775.35	Brought over...		37,44,379.62
5,000.00	Audit Fee	5,000.00	
1,865.00	Xerox Servicing Charges	15,114.25	
74,845.30	Repairs and maintenance to furniture and equipment	72,433.50	
2,31,050.80	Repairs and maintenance to electrical fittings	5,029.40	
11,258.00	Insurance other than building	21,868.00	
12,500.00	Professional and Legal Fees	11,500.00	
76,387.00	Computer maintenance and stationery	85,488.50	
4,12,906.10			2,16,433.55
	AMOUNT WRITTEN OFF		
6,534.00	Receivable from Bihar Government		Nil
	PRIOR PERIOD ADJUSTMENT		
2,30,804.00	For Unrealised Grant From Govt. Maharashtra 1991-92		Nil
Nil	For Excess claim Of Air Conditioning Grants recorded in earlier years.		1,82,373.42
	MISCELLANEOUS EXPENSES		
2,700.00	Garden Maintenance Expenses	5,650.00	
12,839.50	Beautification of Dr. Sálim Ali Chowk	13,310.00	
42,987.29	General Expenses	40,171.00	
645.00	Aquarium maintenance	154.00	
59,171.79			59,285.00
Nil	Loss On Sale Of Vehicles		4,151.00
	DEPRECIATION		
	(Met out of fixed assets fund as per Schedule "B")		
	For Previous Year		
3,61,296.58	i) On Furniture and Equipment	9,31,119.42	
88,367.53	ii) On Motor Vehicles	6,53,687.62	
4,49,664.11		15,84,807.04	
52,37,855.35			42,06,622.69

Previous year 1994-95 Rs.	INCOME	Rs.	Current Year 1995-96 Rs.
56,33,595.59	Brought over...		33,42,987.67
33,188.25	b) For Nature Education	33,188.25	
8,000.00	c) For Building Maintenance	8,000.00	
50,000.00	d) Journal Printing from Dept. of Science & Technology, Govt. of India	50,000.00	
89,16,693.57	ii) Other Grants as per Schedule "C" (To the extent utilised during the year)	51,81,778.69	
1,68,827.11	iii) Royal Western India Turf Club Ltd.	Nil	
91,76,708.93			52,72,966.94
	SUBSCRIPTIONS		
	Ordinary Members		
2,08,390.90	Individual	2,85,831.75	
Nil	Foreign	58,293.02	
22,925.00	Students	34,615.00	
1,18,299.50	Corporate Membership	1,30,963.00	
2,00,700.00	Life Membership (Individual)	2,00,150.00	
89,978.95	Journal Members	1,21,815.50	
1,02,177.00	Journal - Non-Members	63,585.25	
42,593.30	Entrance Fee	49,860.00	
7,85,064.65			9,45,113.52
	INCOME		
Nil	From Birds poster	69,399.87	
2,88,804.87	From BNHS Publications (Net)	4,53,196.55	
9,460.36	From Govt. Publications	Nil	
4,01,382.71	From Greeting Cards	9,47,581.93	
44,501.73	From Calendars	4,21,931.08	
671.00	From BNHS Caps	Nil	
131.00	From BNHS Mugs	176.00	
555.00	From T.Shirts	4,450.00	
4.00	From Stickers	839.00	
64.00	From Bags	Nil	
7,45,574.67			18,97,574.43
	OTHER RECEIPTS		
19,240.78	Miscellaneous receipts		46,055.85
1,63,60,184.62			1,15,04,698.41

Previous year 1994-95 Rs.	EXPENDITURE	Rs.	Current Year 1995-96 Rs.	Previous year 1994-95 Rs.	INCOME	Rs.	Current Year 1995-96 Rs.
52,37,855.35	Brought over...		42,06,622.69	1,63,60,184.62	Brought over...		1,15,04,698.41
	Less: Amount transferred from			83,799.46	Royalty on Dr. Sálim Ali's Publications	59,701.60	
	Deferred Grants	11,59,145.70		39,452.00	Post-Graduate Dept. of Bombay University	20,111.80	
			4,25,661.34	Nil	Sale of discarded furniture	3,500.00	
	AMOUNTS TRANSFERRED TO FUNDS AGAINST INCOME (AS PER CONTRA)			58,000.00	Transparency Fee	12,500.00	
				35,801.00	Staff Gratuity	Nil	
				1,08,990.00	Surplus on surrender of units of UTI	1,19,255.00	
	i) SPECIFIC PURPOSE DONATIONS			Nil	C.C.C. in ornithology	46,270.85	
400.00	SANCF Corpus Fund	Nil		Nil	EIA Consultancy Fees	8,07,461.75	
600.00	Charles Maccan Fund	600.00		Nil	Govt. Publication Fund	2,260.65	
15,00,000.00	ICICI Environment Research & Education Fund	Nil		69,000.00	Sale proceeds of vehicles (net of repairs)	Nil	
				Nil	Bird Hazard Airport Survey (Net)	57,626.00	
20,00,000.00	TISCO Conservation Education, Research and Awareness Fund	Nil		3,95,042.46			11,28,687.65
					ADMINISTRATIVE FEES		
				5,68,971.24	For Project Funds	5,70,978.25	
Nil	Proposed Institute Fund	5,00,000.00		1,017.32	For Govt. Publication Funds	1,844.75	
1,00,000.00	Sálim Ali Memorial Fund	Nil					
Nil	Chennas Fund	5,000.00		5,69,988.56			5,72,823.00
36,01,000.00			5,05,600.00		**EXPENSES MET FROM VARIOUS FUNDS AS PER CONTRA)**		
	ii) OTHER INCOME						
Nil	Entrance Fees Fund	49,860.00			For Natural History Studies		
2,00,700.00	Life Membership Fees Fund	2,00,150.00		2 ,12,283.64	Sálim Ali Nature Conservation Fund	1,82,893.28	
Nil	Govt. Publication Fund	2,260.65		1,12,669.00	Staff Gratuity Fund	98,112.00	
41,899.73	50% Royalty on Dr Sálim Ali's publication	29,850.80		4,49,664.11	For Depreciation	Nil	
69,000.00	Fixed Asset Funds	3,500.00		12,839.50	Sálim Ali Memorial Fund	13,310.00	
4,72,722.57	Interest allocation to funds	7,51,483.76		1,00,000.00	For Publication Fund (John Gold Painting)	Nil	
35,801.00	Staff Gratuity Fund	Nil		17,155.95	Staff Welfare Fund	13,398.80	
33,188.25	Nature Education Scheme 1995-96	33,188.25		65,000.00	From General Reserve Fund (For Various Exp.)	Nil	
3,373.00	Interest On Loan To Staff	1,916.00					
8,56,684.55			15,77,809.46	1,12,291.68	ICICI Environment Research & Edn. Fund	1,87,500.06	
				77,479.44	TISCO Conservation Education Research and Awareness Fund	2,80,000.00	
				11,59,383.32			7,75,214.14
96,95,539.90			62,10,093.49	1,84,84598.96			1,39,81,423.20

Previous year 1994-95 Rs.	EXPENDITURE	Rs.	Current Year 1995-96 Rs.	Previous year 1994-95 Rs.	INCOME	Rs.	Current Year 1995-96 Rs.
96,95,539.90	Brought over...		62,10,093.49	1,84,84,598.96			1,39,81,423.20
	APPROPRIATIONS TO FUNDS OUT OF SURPLUS						
25,000.00	Staff Welfare Fund	50,000.00					
Nil	Staff Gratuity Fund	2,912.19					
Nil	Publication Fund	Nil					
Nil	Proposed Institution Fund	Nil					
Nil	Sálim Ali Memorial Fund	Nil					
Nil	General Reserve Fund	Nil					
25,000.00			52,912.19				
	EXPENDITURE ON THE OBJECTS OF THE TRUST						
3,12,283.64	Expenses met out of funds as per Schedule "B" (On nature conservation activities)	1,82,893.28					
71,38,430.57	Expenses on different Nature Conservation Projects met out of grants as per schedule "C"	51,81,778.69					
1,34,709.50	Journal printing and posting	3,88,641.08					
2,63,335.44	Hornbill Printing and Postage	6,90,966.30					
1,85,932.51	Nature Eduation	16,755.59					
1,09,573.50	Members Activities	1,82,420.07					
1.10.553.21	Library, Books Binding, Subscriptions & Contingencies	1,04,697.61					
3,12,559.81	Reference Collection Maintenance Exp.	4,77,845.73					
86,05,206.18			72,25.998.35				
1,83,25746.08		1,34,89,004.03		1,84,84,598.96			1,39,81,423.20

Previous year 1994-95 Rs.	EXPENDITURE	Rs.	Current Year 1995-96 Rs.	Previous year 1994-95 Rs.	INCOME	Rs.	Current Year 1995-96 Rs.
1,83,25,746.08	Brought over...		1,34,89,004.03	1,84,84,598.96			1,39,81,423.20
37,828.00	Postgraduate Dept. of Bombay University	9,566.00					
1,57,284.10	Laboratory Expenses and Contignecies	2,09,610.05					
Nil	Correspondence Course in Ornithology	15,584.50					
Nil	Nature Enthusiast World	1,49,000.00					
Nil	Conservation Education Project	99,085.00					
			4,82,845.55				
1,568.78	Balance of Surplus Carried Forward		9,573.62				
1,58,852.88							
184,84,598.96			1,39,81,423.20	1,84,84,598.96			1,39,81,423.20

BOMBAY NATURAL HISTORY SOCIETY

Sd/-
HONORARY SECRETARY

Sd/-
HONORARY TREASURER

AS PER OUR REPORT OF EVEN DATE

Sd/-
HABIB AND COMPANY
CHARTERED ACCOUNTANTS

Bombay
Dated: 31st January, 1997

BOMBAY NATURAL HISTORY SOCIETY

ANNUAL GENERAL MEETING HELD ON 13TH MARCH 1997

The Annual General Meeting (AGM) of the Society for the year 1995-96 was held on 13.3.1997 at the Hornbill House at 6.30 PM when the following members were present:

Mr D V Shanbhag, Mr Roshan R Panthakee, Maj. B G Padbidri, Mr D C Balsara, Mr Nitin Adhikari, Mr S K Panigrah, Mr Ravi Mahimkar, Mr Anish Kapadia, Mrs V Deshmukh, Dr S Unnithan, Mr K K Vajifdar, Mr T R Munsiff, Mrs M Kirloskar, Mr S Asad Akhtar, Mr Sunil R Zaveri, Mr Suresh Pradhan, Mr Ulhas Paralkar, Mr Shahid Ali, Mr Atul Mathur, Mr B S Swami, Mr Rokad Zubair, Mr Ulhas Rane, Ms Neelam Patil, Dr A S Kothari, Mr J C Daniel, Dr A R Rahmani, Dr B F Chhapgar, GVK Unnithan, Mr N P Behramfram, Mr R D Dighe, Mrs V R Dighe, Mr R S Moral, Mr Amit Srivasatava, Mr N Chaturvedi, Dr A M Bhagwat, Col. J C Sawhney, Mr C D Singh, Ms Ronita Torcato, Mr D V Golatkar, Dr C V Lattoo, Mrs M S Deshpande, Mr Sunjoy Monga, Mr K P Karamchandani, Mrs S K Vajifdar, Mr R H Kumavat, Maj. Madhav Mhaskar, Mr Leon Lobo, Mr K K Trivedi, Mr Rudi Rego, Mr Shashank Ranjit, Mr V R Khambatta, Mr G M Bodhe, Mr T V Jose, Mr N D Mulla, Mr Rohit Agarwal, Mr Nitin Jamdar, Mr Subhash Bijlani, Lt Gen. V B Jetley, Mr D Bannerjee, Mr Anil Kunte, Mr Manish Vedak, Ms Dina Guha, Dr Vinod Joshi, Mr Govind Swarup, Ms Neelim Gohil, Ms Jayashree Sethna, Mr M M Khan, Mr K N Naoroji, Mr Manoj Karkhanis, Ms Nargis Madiman, Ms Nita Mehta, Mr Mihir Devare, Ms Doreen D'Sa, Mr Parvez Cama, Mr S D Bhaumik, Mr Rishad Naoroji, Mr Shyam Ghate, Mr Joslin Rodrigues, Ms Neeta Sukhtankar, Mr S B Chandak, Dr Rachel Reuben.

FELICITATION TO DONORS

Before the commencement of the AGM, Mrs D S Variava, Vice President thanked those who had donated more than Rs 1 lakh to the Society during the year 1995-96 and since they were not represented, their mementos were sent:

1. Associated Cement Companies Ltd.
2. Seth Purshotamdas Thakurdas and Divaliba Charitable Trust
3. Tata Power Companies

Mrs Variava extended thanks to Mr B G Deshmukh and Dr P R Saraiya for the donations that had been received, and all members for making the Sálim Ali Centenary Year a great success.

This programme was followed by Tea.

The AGM then started at 6.30 PM with Mrs Variava in the Chair.

The Chairperson introduced all Executive Committee (EC) members and informed the members of Mr Deshmukh's inability to attend the AGM as he was attending a meeting in Delhi of the Indian Board for Wildlife on behalf of BNHS.

AGENDA ITEM NO. 1: CONFIRMATION OF THE MINUTES OF THE AGM HELD ON 12.12.1995

i. On page 5 of the minutes second last paragraph

To delete : "...... but he has had problems with the EC".

ii. On page 7 Agenda Item no. 6 (A) second paragraph following should be added after "..... Society or otherwise".

"Mr Rane read out the Charity Commissioner's order".

iii. On page 8, before President's resignation, the following should be added :

Mr Mulla proposed a vote of thanks but immediately thereafter stated that the House had not considered the question of requesting the

President to withdraw his resignation. The Chairman then called the meeting to order and the following resolution was passed *nem con*:

"Mr N D Mulla proposed and Mr M R Almeida seconded the resolution requesting the President, Mr B G Deshmukh to withdraw his resignation from the Presidency of the Society. The resolution was approved unanimously by the General Body".

AGENDA ITEM NO. 2:
CONSIDERATION AND ADOPTION OF THE ANNUAL REPORT OF THE EXECUTIVE COMMITTEE FOR THE YEAR ENDED 31ST MARCH 1996.

i. Mr Zaveri pointed out that on page 4 - 'New Titles' - "Sálim Ali's India" name was missing which should come under 'Under Production'. He was advised that in the year under report, "Sálim Ali's India" was planned to be produced as a Souvenir, and not as a book, hence its ommission from the Publications Sub-Committee's report. The Chairperson stated that it should now be included.

ii. There should be sufficient information on Projects under specific heads. The Chairperson was of the opinion that successful completion of major projects should be mentioned in the President's Message.

iii. It was agreed that the name of new projects sanctioned but grants not yet received should be mentioned in the report.

iv. Dr Kothari pointed out that L & T's donation of Rs 40,000/- has not been mentioned in the list of donations for "Sálim Ali's India". The Chairperson clarified that the actual sums received upto 31st March 1996 were only mentioned in the list.

Dr B F Chhapgar proposed and Mr Sunil Zaveri seconded the adoption of the Annual Report. It was so adopted.

AGENDA ITEM NO. 3:
CONSIDERATION AND ADOPTION OF THE BALANCE SHEET AND STATEMENT OF ACCOUNTS FOR THE YEAR ENDED 31ST MARCH 1996.

i. Mr Sunil Zaveri pointed out some donations had been missed out and the Chairperson stated that the same should be recorded with apologies. It was also decided that where commitments had been received in writing but cash was to be received the same should be mentioned as such.

Mr Zaveri stated that he was not in agreement with the accounts as presented and wishes to be absolved from responsibility for the same.

ii. Points raised by Mr Zaveri and Mr Anish Kapadia regarding discrepancies in the balance sheet and accounts were noted and the Honorary Treasurer replied that he would do the needful.

iii. While answering Mr Manoj Karkhanis's query about how Mr Zaveri was questioning the accounts when his name has come as Honorary Treasurer in the Annual Report, the Chaiperson explained that Mr Zaveri was handling all accounts of the Society but unfortunately he had to resign as his work required him to go out of Bombay, and Mr Haritwal had taken over as Honorary Treasurer and finalised the accounts with the Auditors.

iv. Regarding points raised by Mr Zaveri, the Chairperson stated that the accounts were finalised in consultation with the auditors who had been auditing our accounts for the last several years. The Chairperson suggested that Mr Kapadia could sit with Mr Zaveri and discuss the points.

v. Mr Sunil Zaveri answered to Mr Atul Mathur that since he had not received a reply either from the present Honorary Treasurer or from the Auditors with whom he had meetings, he had raised some points but since the Chairperson had assured that they will be dealt with, he did not wish to pursue the matter at the AGM.

vi. There was considerable discussion on the question of accepting the accounts in view of the queries raised by Mr Sunil Zaveri. Mr Nitin Jamdar, Dr R Reuben, Mr C D Singh, Mr Ulhas Rane gave their opinion on the advisability of accepting the accounts as presented or requesting the Honorary Treasurer to reconsider the presentation of accounts. Finally after Mr Zaveri had assured that there was no question of misappropriation and that his disagreement with the Honorary Treasurer and Auditors was only on a matter of interpretation of provisions relating to the presentation of the accounts of a Charitable Trust, the Chairperson requested the members of the House to propose adoption of accounts. Col. Sahani proposed and Mr Rane seconded that the balance sheet and accounts be adopted. The matter was put to vote and was passed with 33 votes for and 11 votes against.

AGENDA ITME NO. 4: APPOINTMENT OF AUDITORS FOR THE YEAR 1.4.1996 TO 31.3.1997 AND FIXING OF THEIR REMUNERATION.

It was proposed by Mr Sunil Zaveri and seconded by Dr A M Bhagwat that M/s Habib & Co., Chartered Accountants, Mumbai 400023, be reappointed as the Auditors for the Society for the year 1.4.1996 to 31.3.1997 on a total remuneration of Rs 5000/- (Rupees five thousand only).

It was so resolved.

AGENDA ITEM NO. 5: TO CONSIDER REVISION/ADDITIONS TO THE RULES OF THE SOCIETY.

The Chairperson briefed the members about the revision/additions to the rules and informed that it would not be possible to take up this issue in this meeting as the ED had decided that it should go for referendum.

The Honorary Secretary gave a brief resume of the status of Publications, Nature Education, Conservation Education Project & Centre, University Studies, Library, Research & Collections (Projects), Sálim Ali Birth Centenary Celebrations and other activities of the Society.

The Honorary Treasurer gave a report on the financial status of the Society and the need to assure that the long term funds of the Society of Rs 278 lakhs which are grossly under covered by the investments and fixed assets of Rs 224 lakhs to be corrected speedily to secure long term solvency of the Society. The Chairperson appreciated the work done by the Honorary Secretary and Honorary Treasurer.

On a query from Mr Parvez Cama, the Chairperson advised the memebrs about the change of Honorary Secretary.

Members appreciated the work done by Mr B G Deshmukh as the President and also by the outgoing office bearers, namely, Dr P R Saraiya as the Vice President and Dr A M Bhagwat as the Honorary Secretary.

AGENDA ITEM NO. 6: ANY OTHER BUSINESS WITH THE PERMISSION OF THE CHAIR.

Resolutions received:

i. from Mr Bittu Sahgal :

"Resolved that the BNHS should henceforth be more pro-active on the conservation front. If necessary, the Society should examine the possibility of using legal options to demand that the provisions of the Wildlife (Protection) Act and the Forest (Conservation) Act be enforced by various States and the Centre".

— Mrs Meera Deshpande was of the opinion that once in two months we should have a meeting between BNHS experts and Forest Department, Policy makers, Jornalists and thrash out the problems.

— The Chairperson gave the EC's view and read out the modified resolution as proposed by the EC:

"Resolved that the BNHS should continue to be active on the conservation front. If necesssary, the Society should examine the possibility of using or supporting legal action to demand that the provisions of the Wildlife (Protection) Act and the Forest (Conservation) Act be enforced by various States and Centre".

— Mrs Vijaya Deshmukh was of the opinion that we should accept this resolution as the Society's collective thinking.

— Maj. Madhav Mhaskar was of the opinion that since we had scientists, active members and volunteers, we should take matters to court. He also expressed concern about the Arunachal Pradesh deforestation and encroachment at the Sanjay Gandhi National Park.

— Mr Suresh Sawant enquired about the possibility of having a Sociologist at the Society to measure the social impacts on protected areas. The Chairperson stated that the Society' management is conscious about this particular aspect and would do so whenever funds permitted.

— Amended resolution of the EC was proposed for adoption and adopted nem con.

ii. Resolution received from Mr Parvez Cama: "Resolved that rules and procedures in the Library that are discriminatory or derogatory towards members or create unnecessary difficulties for them should be abolished immediately. All rules and procedures, old and new, and for members and staff should be written down and displayed on the Library Notice Board. New rules, additions, amendments or changes to any of the rules, shuld be also written down and displayed on the Notice Board with the signature of the person or body making these above mentioned rules, changes, amendments or additions".

(Proposed by Mr Parvez Cama & seconded by Mr Phiroze Cama)

— The Chairperson read out the amended resolution as proposed by the EC as follows: "Resolved that all current rules and procedures for library users should be written down and displayed on the Library Notice Board indicating the authority making the rules/amendments to the rules".

— Maj Mhaskar was of the opinion that this kind of thing is a part of library administration and there is no need to put a resolution to which the Chairperson answered that every member is entitled to put up a resolution and it is to be dealt with as per Society's Byelaws.

— After considerable discussions about the bag checking counter at the reception, the Honorary Secretary clarified that it is an administrative matter and for welfare of the Society.

— While answering Mr Cama's query regarding filling up the form before referring to books, the Chairperson explained that this is just to get to know how many people are referring to the valuable books.

— Dr Reuben briefed the meeting about the discussions they had with members regarding library matters and informed the idea behind starting slip system and bag counter at the reception.

The Resolution as amended by the EC was then adopted nem con.

The meeting terminated with a vote of thanks to the Chair.

THE SOCIETY'S PUBLICATIONS

The Book of Indian Animals, by S.H. Prater, 4th edition (Reprint)	*(Price to members Rs. 210)*
The Book of Indian Birds, by Sálim Ali, 12th edition	*(Price to members Rs. 296)*
A Pictorial Guide to the Birds of the Indian Subcontinent, by Sálim Ali & S. Dillon Ripley. (Reprint with corrections)	*(Price to members Rs. 278)*
Checklist of the Birds of Maharashtra, by Humayun Abdulali, 2nd edition	*Rs. 2*
The Book of Indian Reptiles, by J.C. Daniel	*(Price to membersRs.162)*
Some Beautiful Indian Trees, by E.Blatter and W. Millard	*(Price to members Rs. 225)*
Conservation in Developing Countries: Problems and Prospects, Edited by J.C. Daniel and J.S. Serrao	*(Price to members Rs. 300)*
A Week with Elephants - Proceedings of the International Seminar on Asian Elephants, Edited by J.C. Daniel and Hemant Datye	*(Price to members Rs. 338)*
A Guide to the Cranes of India, by Prakash Gole	*(Price to members Rs. 67)*
Sálim Ali's India, Edited by A. Kothari and B.F. Chhapgar	*(Price to members Rs. 900)*
Illustrated Flora of Keoladeo National Park, Bharatpur, Rajasthan, by V.P. Prasad, Daniel Mason, Joy E. Marburger & C.R. Ajith Kumar	*(Price to members Rs. 525)*
The Book of Indian Trees, by K.C. Sahni	*(Price to members Rs. 210)*

Types of membership, fees and subscription for publications (As on April 1996)

Type of membership	Entrance fees	Membership fees	Annual subscription for	
			Hornbill	Journal
I. Individual Ordinary				
(a) Resident within India	Rs. 50	Rs. 250 (annual)	Free	Rs. 80
(b) Resident in Bangladesh, Bhutan, Nepal, Pakistan and Sri Lanka	Indian Rs. 50	Indian Rs. 200 (annual)	Free	Indian Rs. 150
(c) Resident outside India, in countries other than those under (b) above	£ 2	£ 12 (annual)	Free	£ 13
II. Individual-Life				
(a) Resident within India	Rs. 50	Rs. 3,000 (1 time)	Free	Rs. 2,000 (Journal)
(b) Resident in Bangladesh, Bhutan, Nepal, Pakistan and Sri Lanka	Indian Rs. 50	Indian Rs. 3,000 (1 time) Rs. 5,000 (with Journal)	Free	
(c) Resident outside India, in countries other than those under (b) above	£ 5	£ 400 (1 time)	Free	Free
III. Individual-Student (only within India) Proof of studentship from concerned institution required at the time of enrolling and renewal every year	Rs. 25	Rs. 75 (annual)	Free	Rs. 80
IV. Instituitional/Corporate				
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AVIFAUNA OF THE ANAIMALAI HILLS (WESTERN GHATS) OF SOUTHERN INDIA[1]

Ragupathy Kannan[2]

(*With thirty-two text-figures*)

Key words: Anaimalai Hills, Western Ghats, India, evergreen forest, birds, conservation.

Ornithological records obtained in the Anaimalai Hills during a 2-year period between 1991 and 1993 are presented. Information concerning nidification, seasonal occurrence and relative abundance are furnished wherever possible. Historical comparisons are made and conservation concerns raised for some species that are typical of the evergreen forest habitat. A total of 218 species were recorded, including 12 Western Ghats endemics. Some significant species not noted in this period are also discussed. The quantitative information on relative abundance presented herein will facilitate objective comparison with population trends in the future. It is hoped that this account would: a. serve as a bedrock for the development of a more comprehensive database of the avifauna of this unique, threatened physiographic area, and b. stimulate the development of census programmes here and elsewhere in the Western Ghats for long-term monitoring of forest bird populations.

Introduction and Study Area

The Anaimalais (Tamil: *Anai*=elephant; *malai*=hills) is a range of lofty mountains in the southern Western Ghats of India, extending from Coimbatore dist., western Tamil Nadu in the east, to the southeastern fringes of the Nelliampathy Hills of Kerala in the northwest. Southwards, the Anaimalais are contiguous with and part of the High Range and Kanan Devan mountains, wherein lies Anaimudi, the tallest peak in southern India (2695m) (Fig. 1). Ornithological information from the Anaimalais is scarce, largely because of the absence of any established hill station resort in these hills. In contrast, the adjacent ranges of Palnis and Nilgiris have historically been well covered by various ornithologists and birdwatchers due to the accessibility afforded by two major hill stations, Kodaikanal and Uthagamandalam respectively. Burg *et al.* (1994), in their extensive bibliography of Indian ornithology, cite more than ten articles concerning the avifauna of Palnis and Nilgiris which appeared in the Society's Journal between 1877 and 1958. Even the adjacent Nelliampathy Hills have been well surveyed, the bulk of the work being that of Kinloch (1921, 1923a and b), who presented detailed accounts on the birds recorded here over a 10-year period. Ali and Ripley (1987) make numerous references to the Palnis and Nilgiris, but mention the Anaimalais scantily. Just one paper on the birds of Anaimalais is cited in the bibliography of Burg *et al.* (1994).

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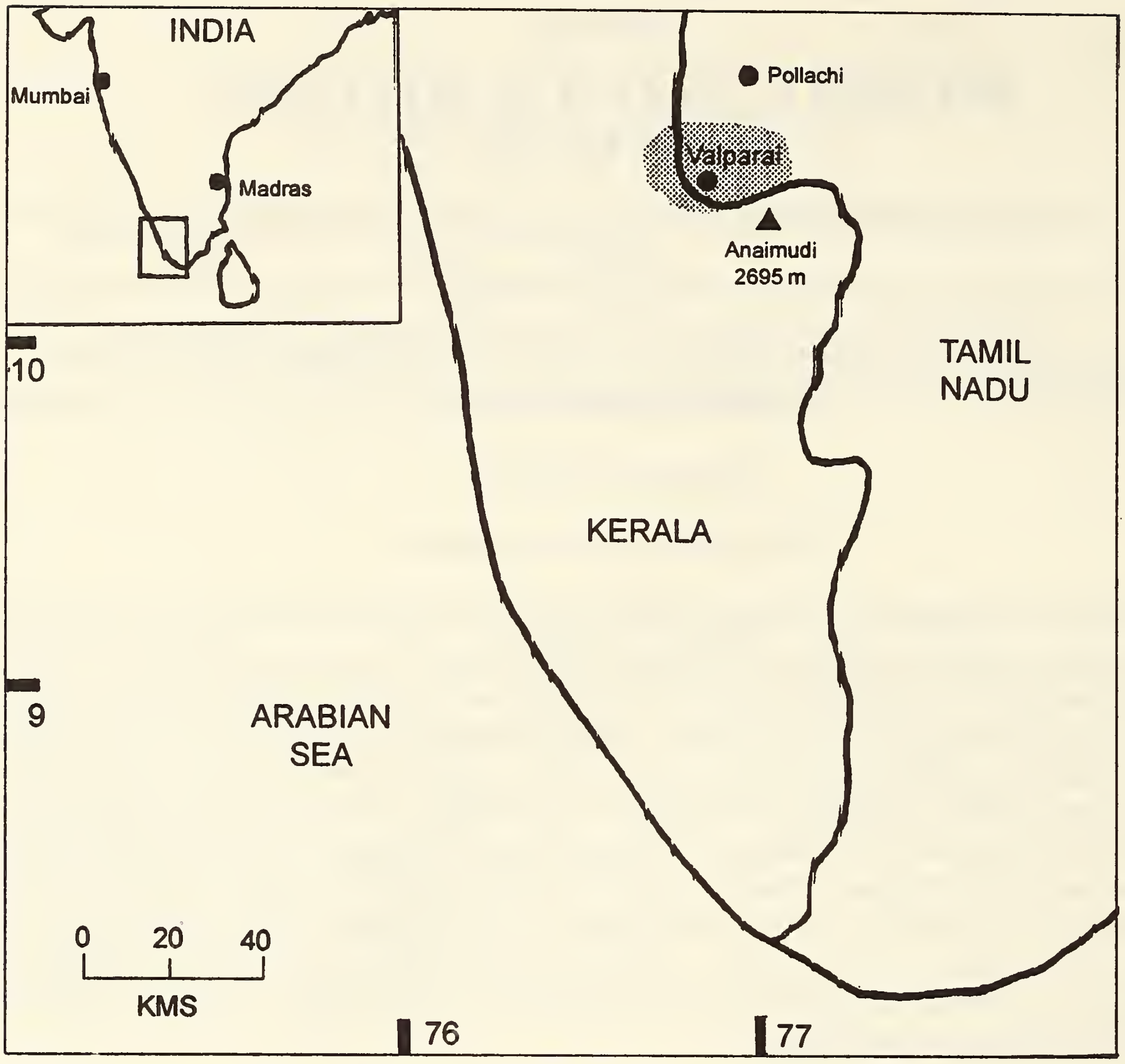


Fig. 1: Southwestern section of the Indian peninsula showing the study area and its approximate extent (shaded gray).

The little that is known specifically on the avifauna of Anaimalai Hills stems mainly from the collection expeditions of Ali (1935-37) and anecdotal notes made by Stonor (1946). Sálim Ali spent a few days in 1933 collecting birds in three localities in the Anaimalais, during a survey of the erstwhile princely states of Travancore and Cochin. Stonor presented observations based on a month-long stay in the Parambikulam area in 1944. More recently, Vijayan (1978) appended a short list of the birds recorded in his general survey report of the Parambikulam Wildlife Sanctuary, and Sugathan (1981) surveyed the same area for the habitat of Ceylon Frogmouth (*Batrachostomus moniliger*). My own recent publications are cited where relevant in this account.

This paper presents the first detailed and systematic account of the avifauna of Anaimalai hills, based on the analysis of bird records and census data collected during a 2-year study, between August 1991 and July 1993, in these hills. The study area (Fig. 1) included the following localities, which covered the entire altitudinal range in this area — from foothills to high elevations.

(i) Indira Gandhi Wildlife Sanctuary, Coimbatore dist., Tamil Nadu: The study was based in Top Slip, a settlement 35 km by road from Pollachi (Fig. 1). Top Slip, named so because lumber was traditionally slipped from the hilltops down to the plains during the colonial era, has had a history of logging. However, some of the evergreen forests in the area have been protected from clear felling. Karian Shola, a patch of Southern Tropical Wet Evergreen Forests (Champion and Seth 1968), that extends right up to the settlement, has recently been elevated to the status of National Park. Rainfall varies heavily with altitude in the sanctuary. Top Slip, located at an elevation of 750 m, experienced a precipitation of 1464 and 1402 mm for the years 1991 and 1992 respectively. The current work focused on the evergreen forests near Top Slip (Karian Shola, Anaigundi Shola, Umayamalai and Varagaliar forests, which lie between 750 and 1000 m).

Periodic bird surveys were carried out at various elevations of the 1250 sq. km sanctuary. The habitats and altitudes covered were: the scrub vegetation at the foothills (*c* 300 m), the deciduous and bamboo forests of the lower slopes (300-750 m), tea and coffee plantations and scattered fragmented sholas (Puthuthottam and Kadambarai) of the Valparai Plateau (1000-1700m) (*c* 10°19' N;76°58' E), and the montane, elfin forests and grassy hills of the highlands (Grass Hills, *c.* 1700-2200m).

(ii) Parambikulam Wildlife Sanctuary (235 km^2) (*c* 10°25' N;76°43' E), Kerala: Bird surveys were carried out periodically in the lush evergreen forests of Karimala Gopuram (peak elevation: 1440 m), the Tunakadavu and Parambikulam Reservoirs and the mixed deciduous forests that surround them, and in the southern section of Karian Shola, which is part of the Sungam Range of the sanctuary. For a detailed description of Parambikulam, see Vijayan (1978) and Sugathan (1981).

Surveys were also done sporadically in two areas on the fringes of the Anaimalai hills: the Sholayar forests (banks of the Sholayar river), south of and contiguous with Parambikulam; and the Chalakudy forests west of Parambikulam, by the old and derelict Chalakudy-Parambikulam Forest Tramline (also called the Cochin Forest Tramline — see Ali (1935) and Vijayan (1978).

Wherever possible, quantitative information is given on seasonal relative abundance based on census data, which is important in the face of the continuing destruction of mature forests all over the Western Ghats, because it provides an objective means with which future trends in population and relative abundance can be compared. A bird list is appended, with status information for each species and the area(s) where they were recorded. Some species that are conspicuously *absent* from this list are also discussed in a separate section. Because much of the work focused around Top Slip, equal coverage could not be extended to all the elevations. However, it is hoped that this work will serve as a foundation for the development of a more comprehensive database for the avifauna of this unique area.

METHODS

Bird records were maintained in detail during the daily field trips in the area. Parameters noted included plumage details, elevation, habitat, feeding, behaviour and evidence of nesting (if any). Quantitative information was gathered by conducting censuses of forest birds along a 1 km line-transect inside Karian Shola. Censuses were done once a week in most months, with up to 10 counts in some months (average: 6.1 counts/ month; N=22 months). The transect started at the edge of the evergreen forest behind Top Slip, where there was a considerable amount of secondary growth. Birds seen and/or heard farther than approximately 100 m from the transect were discounted, but this does not necessarily imply that coverage of the transect was thorough. Censuses were conducted in the early morning hours, the exact time of study varying with weather conditions. When inclement weather conditions precluded a morning census, the work was done in the evening.

The following three criteria were used to determine relative abundance. Assignment of a species to any of these criteria was made exclusively by the number of records for that species over a period of time.

COMMON = Encountered daily in relatively large numbers, more than 10 individuals/day. Examples: Yellowbrowed bulbul, Hill Myna.

UNCOMMON = Observed on most days in relatively low numbers, 1-10 individuals/day, although may be sporadically seen in larger numbers. Examples: Great Pied Hornbill, Crested Serpent Eagle.

RARE = Encountered 15 times or less a year. Infrequently encountered and usually found in small numbers. Examples: Black Crested Baza, Bay Owl.

Results and Discussion

A total of 218 species was recorded, 12 of which are endemic to the Western Ghats (see Appendix). Amongst the more significant records was the rediscovery of the Bay Owl, which constituted the second report of this enigmatic species in the Western Ghats (see species account). The census data yielded a numerical idea of the seasonal relative abundance of many forest birds — a visual display of the patterns obtained is provided (Figs. 2-31), and the patterns are discussed below in the species accounts.

Selected species accounts

Most of the species covered in this section are typical of the highly human-encroached evergreen forest biotope and hence need careful long-term monitoring into the future. For scientific names, see Appendix. Dates are provided wherever they may be significant.

Malay or Tiger Bittern: Rare. One record of a solitary bird seen on 13.v.93 in the evergreen forests of Karian Shola, by the Kerala-Tamil Nadu border.

Black-crested Baza: Rare. Summary of sight records: 10.i.92 single, Karian Shola; 20.xii.92, 21.xii.92, 4 or 5 individuals and a pair, respectively, Karian Shola; 6.i.93, reliably reported from Varagaliar Shola; 6.i.93-9.i.93 a pair seen everyday in Karian Shola; 22.i.93, one seen at Karian Shola - This bird had chestnut coloration on breast band and back, suggesting that it belonged to the Kerala race *A. l. leuphotes*. (No inferences could be made on racial identity of the birds seen earlier).

Crested Goshawk: Rare. A pair seen 24.i.93 in a fluttering circular display flight over the forests of Akkamalai (1727 m) en route to Grass Hills, past the Valparai plateau. Upper tail coverts very white, and this helped in its identification (see King *et al* 1983). One bird seen from within 5 m, perched on ground in Karian Shola 5.iii.93.

Besra Sparrow-Hawk: Rare. Four sight records: 5.xi.92 and 22.i.93, Karian Shola; 26.xii.92 Chalakudy; 27.i.93, Anaigundi Shola.

Crested Hawk-Eagle: Uncommon. Noted regularly all year. Usually seen perched on roadside trees by the Pollachi-Top Sliú hill road.

Observed on ground devouring a freshly killed Grey Jungle-fowl in October 92.

Rufousbellied Hawk-Eagle: Rare. Seen 4 times: 25.x.91, 7.x.92, and 13.ii.93 over Karian Shola; 20.xii.92 over deciduous forests near Top Slip. Constantly harried by crows, more so than other raptors, which was sometimes a clue to its identity from afar.

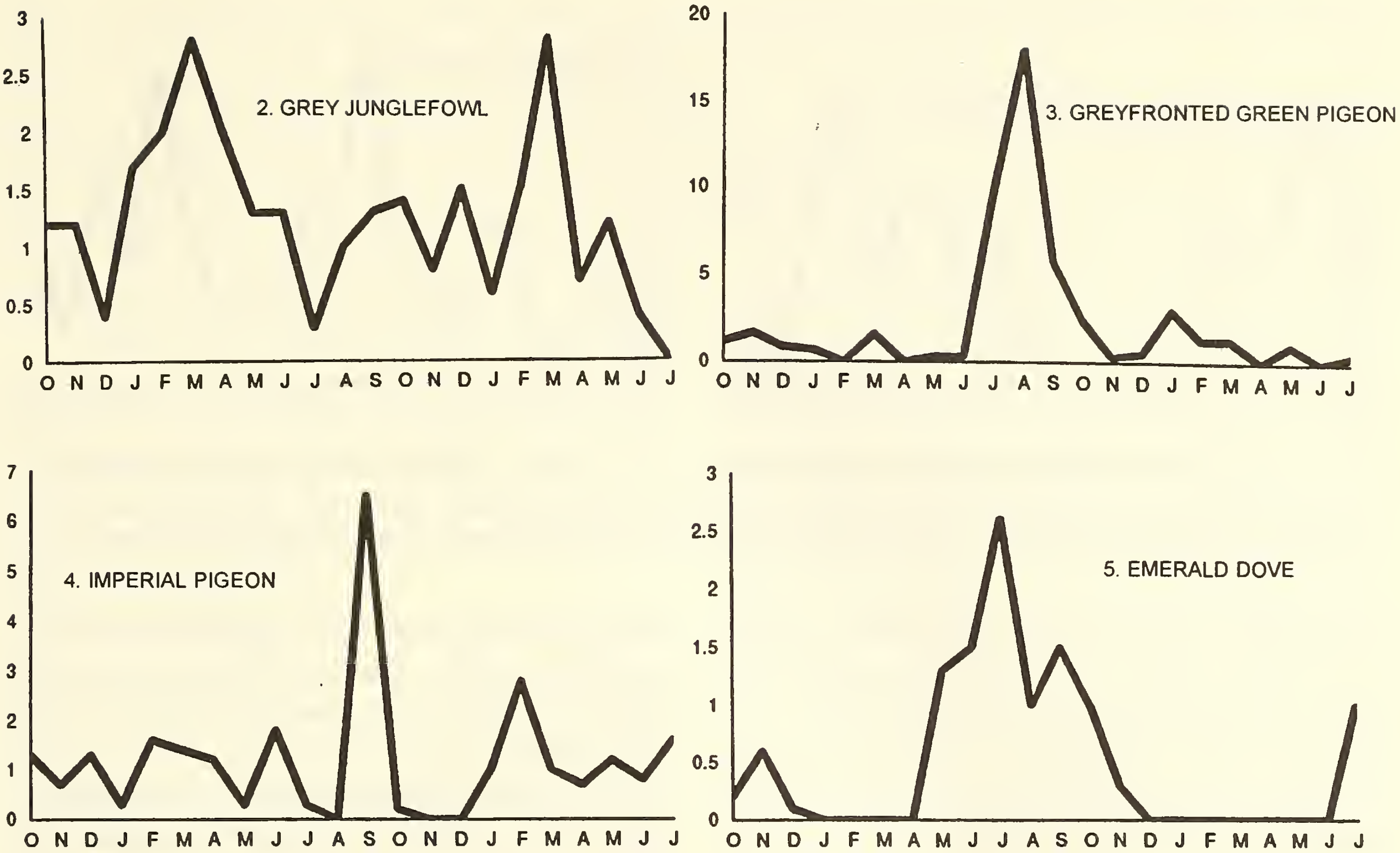
Greyheaded Fishing Eagle: Rare. Seen across the state border by Tunakadavu lake (*c.* 11 km by road SW of Top Slip) 19.x.91. Adult seen carrying nest material (twigs) at Manampalli 23.i.93.

Osprey: Rare. Winter visitor. Seen at Tunakadavu lake October and December 92. Also, one seen on 20.i.93 over foothills scrub.

Shaheen Falcon: Rare. Possibly breeds on the steep cliffs by Pollachi-Top Slip road. One bird seen there 7.xii.92; A pair seen indulging in spectacular midair courtship over foothills scrub 16.xii.92.

Jungle Bush Quail: Rare. Possibly commoner than they appear. Seen once in December 91 on ground in open deciduous forest mixed with bamboo.

Red Spurfowl: Uncommon. Usually seen



Figs. 2-5: Monthly mean relative abundances of four species of forest birds along a 1-km transect through the evergreen forests of Karian Shola, Top Slip, between October 1991 and July 1993. X-axis (abscissa) represents months; Y-axis (ordinate) represents mean number of encounters per kilometre.

in forest clearings. A precocial chick (with a conspicuous yellow mid-dorsal stripe) was seen with a parent on 9.iii.93.

Grey Junglefowl: Common. Breeding resident. Usually 1-2 ($\bar{x}$=1.3/km; N=136 counts) birds encountered in Karian Shola in the census trail (see Fig. 2).

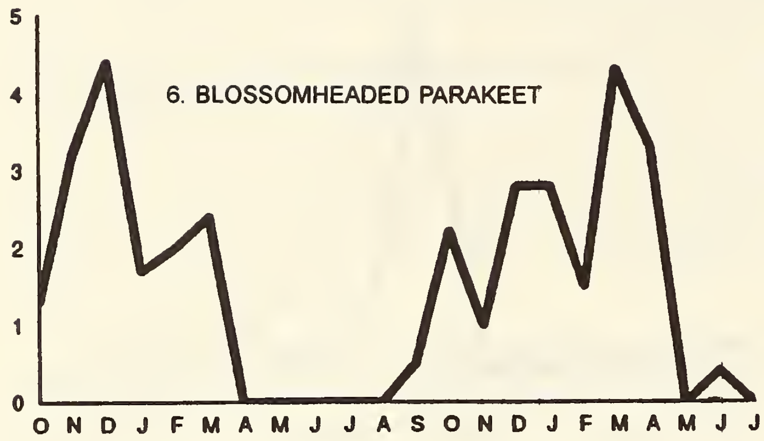
Greyfronted Green Pigeon: Common ($\bar{x}$=2.08/km;N=136 counts). Two nests found in January 93. Local movements dictated largely by fruiting of fig trees, hence the spurt in abundance in certain months (Fig. 3).

Nilgiri Woodpigeon: Rare. Seen twice, single birds on both occasions: 7.xi.91, Karian Shola; and January 93 in mixed bamboo jungle near Top Slip settlement. Ali and Ripley (1987) report it from the Anaimalais, and indicate its presence at all elevations. Judging subjectively from their account, it appears that this species has declined in numbers. Certainly a species that needs close scrutiny of conservation biologists.

Imperial Pigeon: Common. A year-round resident with fairly stable, albeit thin local numbers ($\bar{x}$=1.1/km;N=136 counts) (Fig. 4). The big peak evidenced in September 92 was due to the fruiting of a large fig tree by the census trail.

Emerald Dove: Status varies with season (see Fig. 5). Uncommon from monsoon through the winter season (June-December); Rare or absent in the drier months of spring and summer (January to May). Nest with 2 pale brown eggs incubated by female seen in evergreen forest 27.x.92. Possibly migrates altitudinally to wetter regions after breeding. Returns at the onset of pre-monsoon showers in late May (sighted immediately after pre-monsoon showers on 21.v.93 after a long absence).

Blossom-headed Parakeet: Status varies



Figs. 6-7: Monthly mean relative abundances of two species of parakeets along a 1-km transect through the evergreen forests of Karian Shola, Top Slip, between October 1991 and July 1993. X-axis (abscissa) represents months; Y-axis (ordinate) represents mean number of encounters per kilometre.

seasonally. Common at all times except immediately before and during the southwest monsoon (April-September), during which it is rare or absent (see Fig. 6). It may be an altitudinal migrant with local movements obviously influenced by the monsoon.

Blue-winged Parakeet: Common. Usually 4-5 individuals encountered in the census trail all year ($\bar{x}$=4.8/km;N=136 counts), but occasional peaks of up to 14 individuals evident due to flowering of *Bombax* and other forest flowering trees (Fig. 7).

Malabar Lorikeet: Common ($\bar{x}$=2.08/km; N=136 counts). Local movements influenced by flowering of trees, and hence the fluctuation in local abundance (Fig. 8).

Pied Crested Cuckoo: Rare. Two records: June 92, foothills scrub; 12.v.93, Top Slip. Evidently a southwest monsoon visitor as in many other parts of India (Ali and Ripley 1987, Khachar 1989).

Large Hawk-Cuckoo: Rare. Single adult seen 26.x.91 Karian Shola. Coloration pattern was distinctive enough for identification. Hence, the doubt expressed by Ali and Ripley (1987) on reliability of winter sight records is probably unwarranted, at least for adult birds.

Bay Banded Cuckoo: Status unclear. Recorded mostly aurally between February and May 92 and 93. Song often heard during this time. Evidence supports Ali and Ripley's (1987) contention that the status is difficult to ascertain because of the bird's unobtrusiveness in the nonbreeding season.

Sirkeer Cuckoo: Rare. Noted twice: 16.i.93 in the scrubby, rocky slopes downhill from Top Slip; 20.i.93 in foothills scrub. Ali (1935) and Kinloch (1921, 1923) did not record this species in their surveys of the Anaimalais and Nelliampathies respectively. There is no record of its occurrence in the Palni Hills either.

Bay Owl: Rare. Recorded twice in Karian

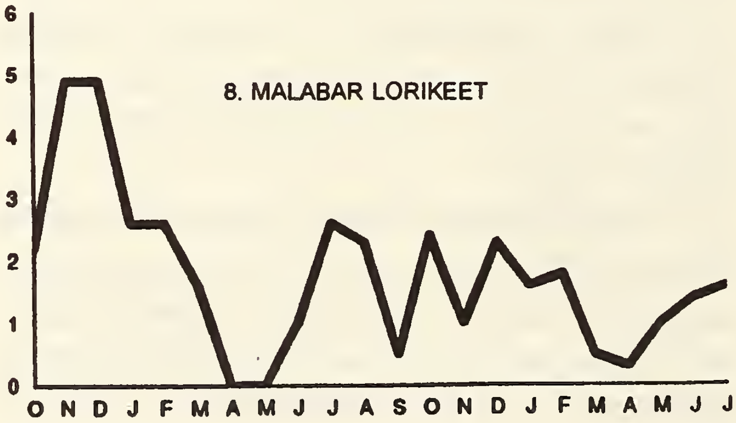


Fig. 8: Monthly mean relative abundance of Malabar lorikeet along a 1-km transect through the evergreen forests of Karian Shola, Top Slip, between October 1991 and July 1993. X-axis (abscissa) represents months; Y-axis (ordinate) represents mean number of encounters per kilometre.

Shola, on Kerala and Tamil Nadu sides of the border, on 14.ii.92 and 6.iv.92 respectively. The bird was photographed at daytime as it perched asleep on a low branch in deep evergreen forest. This was a re-discovery of the species in southern India, following the first report by Hussain and Khan (1978) in the Nelliampathies. See Kannan (1993a) for more details and discussion.

Scops Owl: Status unclear. The familiar, monotonous, *uk-ruku* calls heard often at nights around Top Slip. One bird *seen* calling too, confirming its identification. This suggests that the call of the peninsular Indian race may be the same as that described for the north Indian race (see Ali and Ripley 1987).

Forest Eagle Owl: Rare. Perhaps commoner and overlooked due to nocturnal habits and deep forest habitat. Seen occasionally in Karian Shola in daytime, perched high up in the canopy and often mobbed by grey hornbills and drongos. Once seen feeding on a giant squirrel (Kannan 1994c).

Brown Fish Owl: Rare. May be commoner than it appears for reasons cited above. Seen often (same pair/individual?) by the water hole opposite Karian Shola watch tower.

Brown Hawk-Owl: Uncommon. The repetitive, soft *oo-uk* calls heard almost every night around Top Slip, more so from late December through May, hence probably also breeds in the area. Also, heard at Sholayar.

Ceylon Frogmouth: Rare. Seven records from evergreen and open bamboo forests. These constitute the first record of this species from Tamil Nadu. For details see Kannan (1993c, 1994b). Vijayan (1978) included this species in his Parambikulam list; Sugathan (1981) noted it in Parambikulam during his overall survey of its habitat.

Great Eared Nightjar: Rare, but perhaps commoner. The distinctive whistling *vee-veeeu* calls heard often on moonlit nights January through April inside deep evergreen forests. Flushed occasionally from ground at daytime in several evergreen forest patches (Karian Shola, Varagaliar, Karimala Gopuram, Vengoli). Heard also by the Sholayar river.

Indian Jungle Nightjar: Presumably rare. The unmistakable *chuckoo-chuckoo-chuckoo* call heard near Top Slip twice: 13.ii.93 and 29.v.93, both at dusk from bamboo-clad forested valleys.

Long-tailed Nightjar: Uncommon. Heard almost everyday from dusk through moonlit nights in November-January. Two calls recorded: the commonest call was a loud, shrill *Chowk!* (or *Chaunk*) repeated often through the night. A bird that was seen making this call at Top Slip had typical nightjar features: white on throat, tail and wings (the last seen flashing at flight). The second call was a soft *druk-druk, druk-druk* etc, of the quality of a frog's, usually followed by the commoner call.

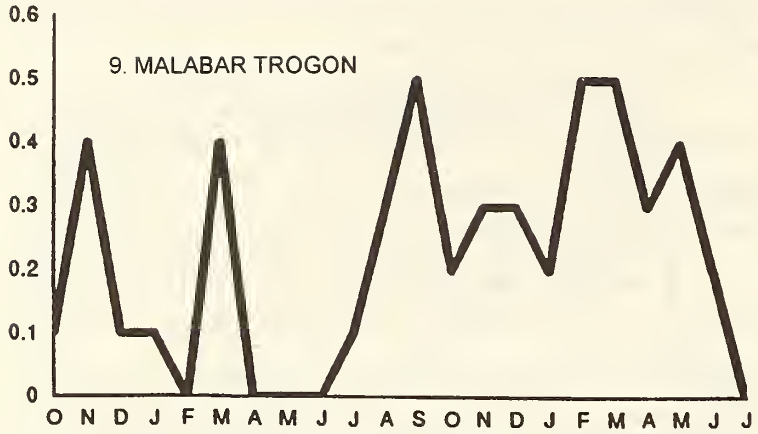
Indian Edible-nest Swiftlet: Uncommon. Seen in small parties flying around cliffs and above shola forests at Top Slip and at higher elevations (Grass Hills). Nowhere was there evidence of the huge colonies reported by Ali and Ripley (1987).

Large Brownthroated Spinetail Swift: Common. Seen every evening as hordes of individuals fly at top speed in a southwesterly direction over Top Slip towards some roosting site. A few individuals occasionally seen flying in the opposite direction early in the mornings, suggesting that the birds probably have a circuitous route.

Whiterumped Spinetail: Rare. Small numbers observed flying in mixed flocks off cliffs and over evergreen forest clearings. Ali (1935) recorded it in Parambikulam, and indicated that the species is uncommon overall in the southern Western Ghats.

Alpine Swift: Rare. One seen on 4.x.91, 6 seen on 6.viii.92 and 2 seen on 23.x.92 near Top Slip.

Malabar Trogon: Uncommon. Most days recorded aurally. Individuals or in loose pairs, widely dispersed in the evergreen forest ($\bar{x}$=0.2/km; N=136 counts), often difficult to find (Fig. 9). Occasionally seen in mixed hunting



Figs. 9: Monthly mean relative abundance of Malabar trogon along a 1-km transect through the evergreen forests of Karian Shola, Top Slip, between October 1991 and July 1993. X-axis (abscissa) represents months; Y-axis (ordinate) represents mean number of encounters per kilometre.

parties. Signs of nesting detected in February 92 when a male was flushed from a hole in a dead stump in deep evergreen forest. Noted also at Kadambarai Shola (Valparai Plateau) and Chalakudy forests.

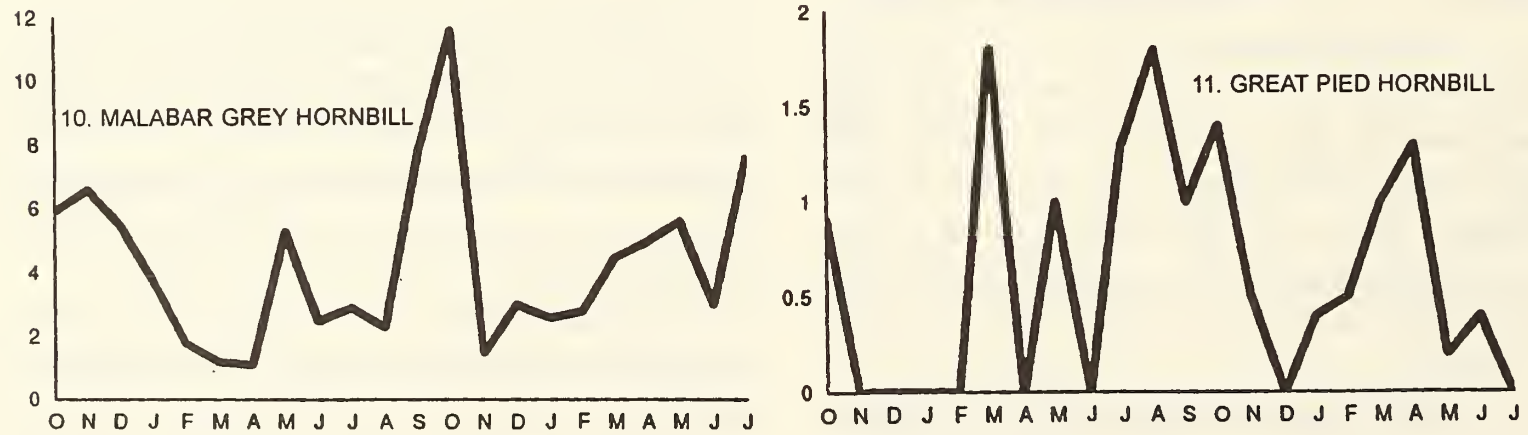
Bluebearded Bee-Eater: Rare. Nests in steep earthern banks flanking hill roads. Excavating parents were often flushed by passing vehicles in December 92. Nests are active by January. Four nests discovered. Seen rarely outside of breeding season, perhaps owing to its sluggishness. Most sightings in open bamboo and deciduous forests. Sometimes seen in evergreen forest edges and clearings.

Broadbilled Roller: Uncommon. Singly or in pairs seen sporadically, in clearings amidst evergreen forest. Curiously no records between December 91 and March 92, and also during the southwest monsoon (June-August) of both years, suggesting some local movements.

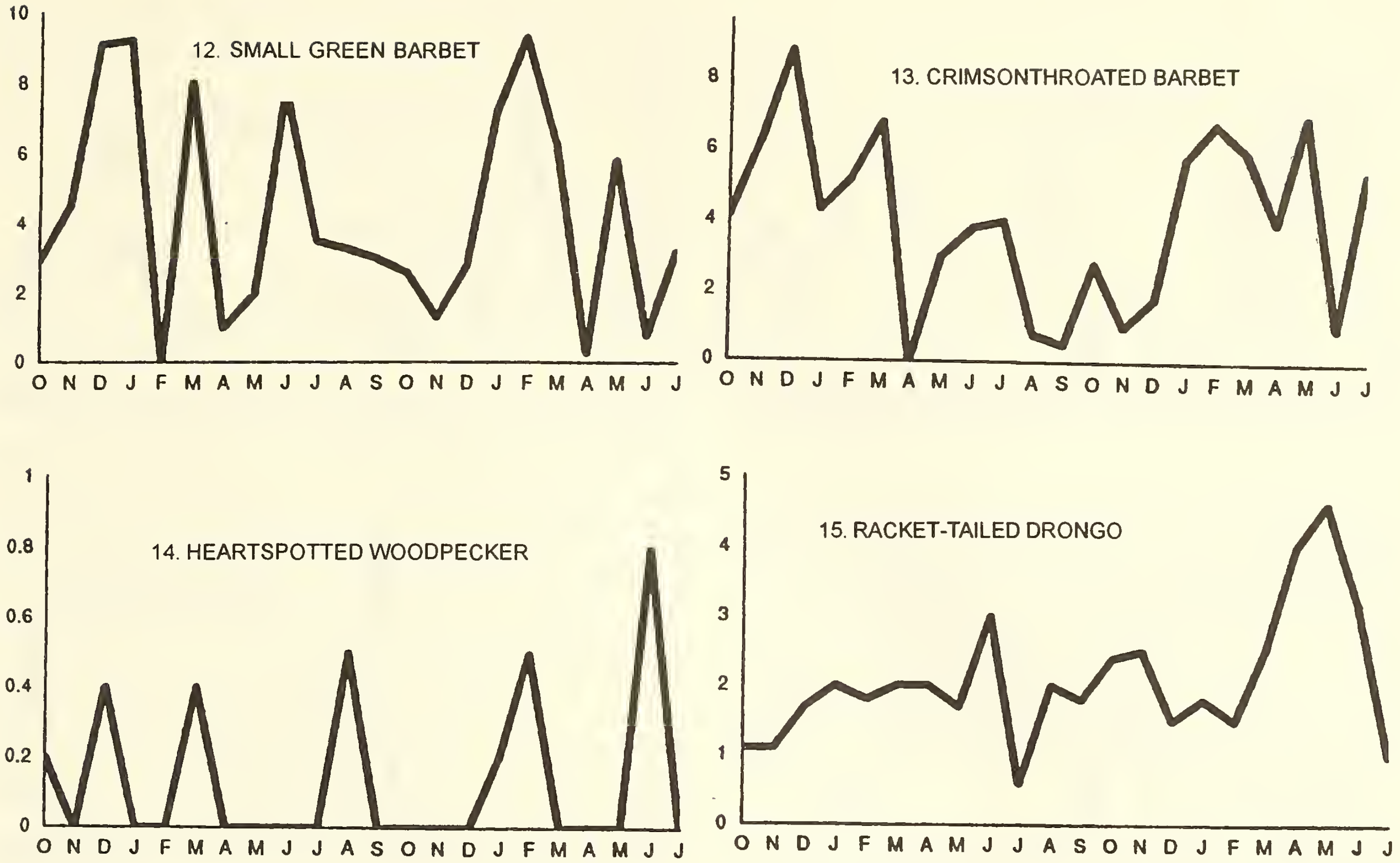
Malabar Grey Hornbill: Common. Breeding resident of evergreen and moist deciduous forests. Average of 4.1 birds encountered per km in Karian Shola (N=136 counts), with occasional peaks caused by the influx of individuals attracted to fruiting fig trees (Fig. 10). For its nesting habitat ecology in the Anaimalais, see Mudappa and Kannan (1996).

Great Pied Hornbill: Uncommon. Breeding resident and locally nomadic. Noted erratically in census trail (Fig. 11). Population in the Top Slip area estimated around 35 birds for most of the year. For details on local status, ecology and conservation issues, see Kannan (1993b, 1994a, 1997). Recorded nesting also at Chalakudy and Sholayar. Nest predation by *Kadar* tribals widespread in Kerala, especially in Chalakudy forests.

Small Green Barbet: Common. As in



Figs. 10-11: Monthly mean relative abundances of two species of hornbills along a 1-km transect through the evergreen forests of Karian Shola, Top Slip, between October 1991 and July 1993. X-axis (abscissa) represents months; Y-axis (ordinate) represents mean number of encounters per kilometre.



Figs. 12-15: Monthly mean relative abundances of four species of forest birds along a 1-km transect through the evergreen forests of Karian Shola, Top Slip, between October 1991 and July 1993. X-axis (abscissa) represents months; Y-axis (ordinate) represents mean number of encounters per kilometre.

many frugivores, local abundance fluctuates widely with respect to the fruiting of figs and other forest fruits (Fig. 12). More vocalisation in summer may partly account for increased frequency of encounters.

Crimsonthroated Barbet: Common ($\overline{x}$=4.3/km; N=136 counts). As in the previous case, wide variations evident in local numbers (Fig. 13), but again, summer census figures may be at least partially biased and inflated by the increased vocalisation.

Rufous Woodpecker: Rare. Seen once, 27.iv.92, in mixed bamboo forests near Top Slip.

Speckled Piculet: Status unknown. Two records, both at high elevations: 29.x.92, Puthuthottam Estate near Valparai town; 12.v.92, evergreen forests of Akkamalai (1700 m) enroute to Grass Hills.

Indian Great Black Woodpecker: Uncommon. Breeding resident. Found in both evergreen and moist deciduous forests. Active nest discovered February 93 in Karian Shola.

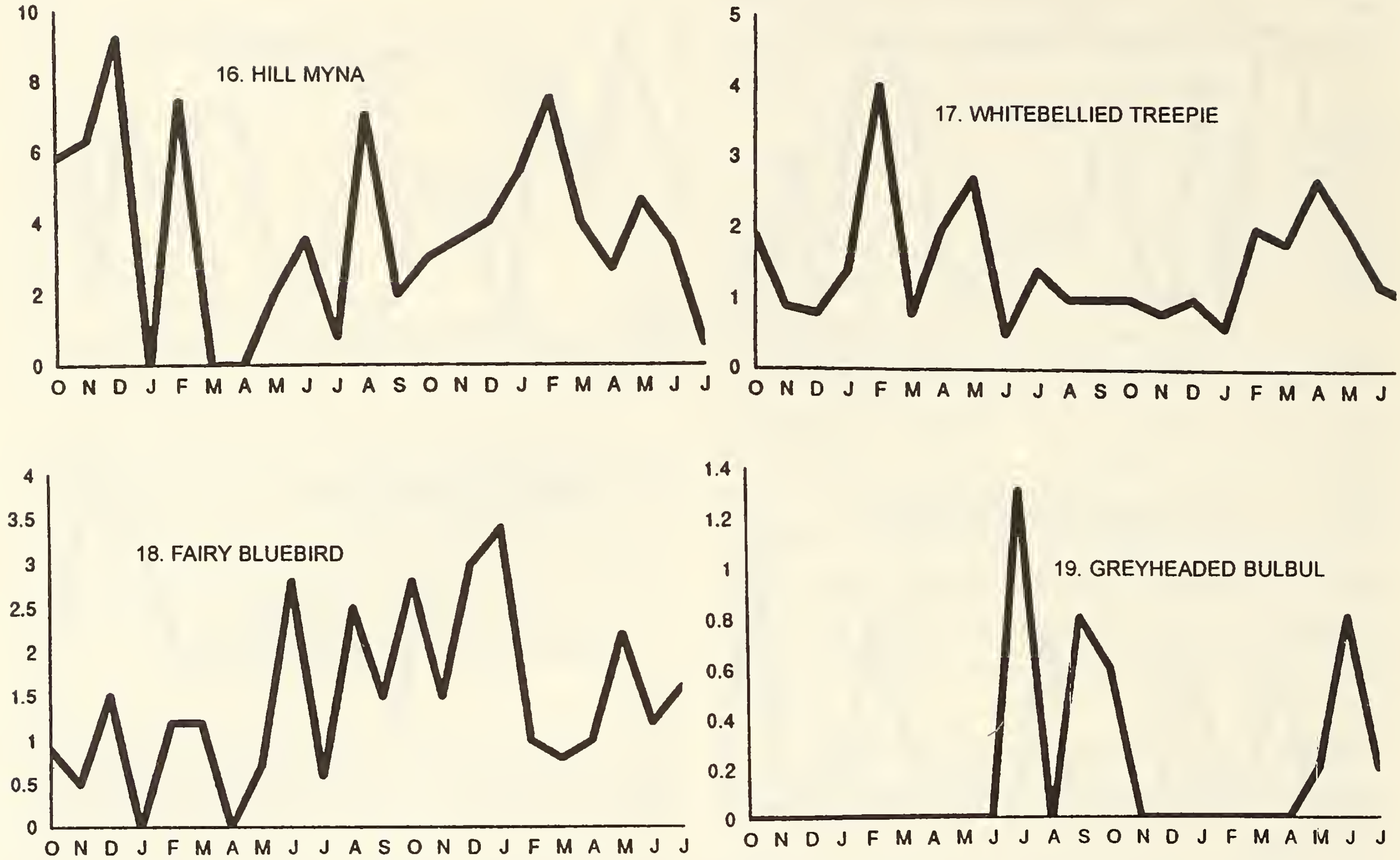
Heartspotted Woodpecker: Uncommon. Occurs in low numbers in evergreen forests (Fig. 14). Adult seen feeding fledged chick 21.v. 92.

Indian Pitta: Rare in Top Slip. Winter visitor. Maybe commoner in lowlands. Heard once each in October 91 and October 92 in Top Slip, presumably on autumn migration; also heard several evenings in January 93 around Top Slip; recorded roosting amongst tea gardens in Valparai; one sighting in the foothills scrub, January 93.

House Swallow: Rare(?) Seen only in Grass Hills. Breeds by the Konalar river.

Blacknaped Oriole: Rare. Winter visitor. Seen in evergreen and mixed forests a few times between January and March 93.

Haircrested Drongo: Rare. Maybe



Figs. 16-19: Monthly mean relative abundances of four species of forest birds along a 1-km transect through the evergreen forests of Karian Shola, Top Slip, between October 1991 and July 1993. X-axis (abscissa) represents months; Y-axis (ordinate) represents mean number of encounters per kilometre.

commoner. Seen a few times in January 93 on flowering *Acrocarpus* trees in Karian Shola.

Greater Racket-tailed Drongo: Common. Densities remain more or less steady throughout the year ($\bar{x}$=1.88/km; N=136 counts, Fig. 15) in evergreen forest. Apparently very territorial. Pugnacious, often seen mobbing hornbills and other birds larger than its size.

Jungle Myna: Common. Occurs above *c* 900m. Absent in Top Slip and in foothills. Common in Valparai plateau past Attakatti. Not seen in Akkamalai (1700 m) or Grass Hills.

Hill Myna: Common. Recorded in good numbers in census trail ($\bar{x}$=6.8/km; N=136 counts, Fig. 16). Absent at times, suggesting some wandering. Despite its commonality, may warrant monitoring in the wake of its growing popularity as a cage bird in Coimbatore dist.

Whitebellied Treepie: Common. Between 1-2 ($\bar{x}$=1.5/km; N=136 counts) individuals counted regularly in the census trail (Fig. 17). Adult observed feeding fledged chick in summer 92. Observed in moist deciduous and evergreen forests from about 600 to 800m.

Fairy Bluebird: Common. Usually a pair seen per km ($\bar{x}$=1.25/km; N=136 counts) in appropriate habitat (Fig. 18), but numbers vary in accordance with fruiting of figs and other trees.

Greyheaded Bulbul: Rare. This Western Ghats endemic was recorded in small numbers only during the rainy season between late May and November (Fig. 19). More often heard than seen. The harsh *chrweet* call is somewhat reminiscent of that of the Bluethroat (*Erithacus svecicus*), and is often the only cue to its presence. Difficult to observe owing to seclusive habits and thick undergrowth habitat. This data suggests that the species could be a local migrant with regular routes mediated by the monsoons, as in Emerald Dove (Fig. 5). At least 10 birds noted in a riverine patch of forest by the old tramline in Chalakudy forests, 26.xii.92.

Yellowthroated Bulbul: Rare. A pair seen once by the Pollachi-Valparai road, 28 kms from Pollachi, 12.v.92 (Kannan 1992). The spot is just above Aliyar Dam. The birds were seen on small trees by a roadside waterfall. Not seen there in subsequent searches. Ali and Ripley (1987) mention an 1886 record of Davison's from the Anaimalais. The status of this species is of interest considering its restricted distribution in peninsular India. The extensive removal of hill scrub (its prime habitat) due to quarrying and fuel wood collection elsewhere in its range, I have observed, is cause for concern.

Rubythroated Bulbul: Uncommon. Partial to forest edge habitat. In very small numbers at forest edges, more or less all year (Fig. 20). Has a particular preference for *Lantana* berries, which attract adjoining populations of this species.

Yellowbrowed Bulbul: Common. Between 5-14 birds seen regularly on census trail ($\bar{x}$=10.4/km; N=136 counts, Fig. 21). The relatively steady seasonal abundance curve is suggestive of the sedentary nature of the species. Nests from January-May. Stonor (1946) too found it common in the area.

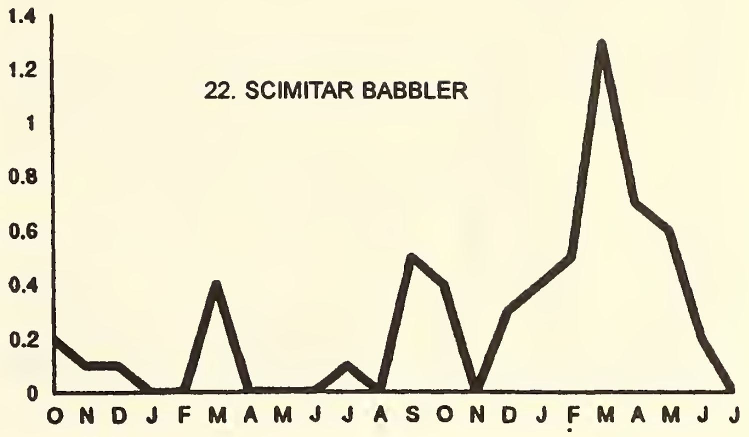
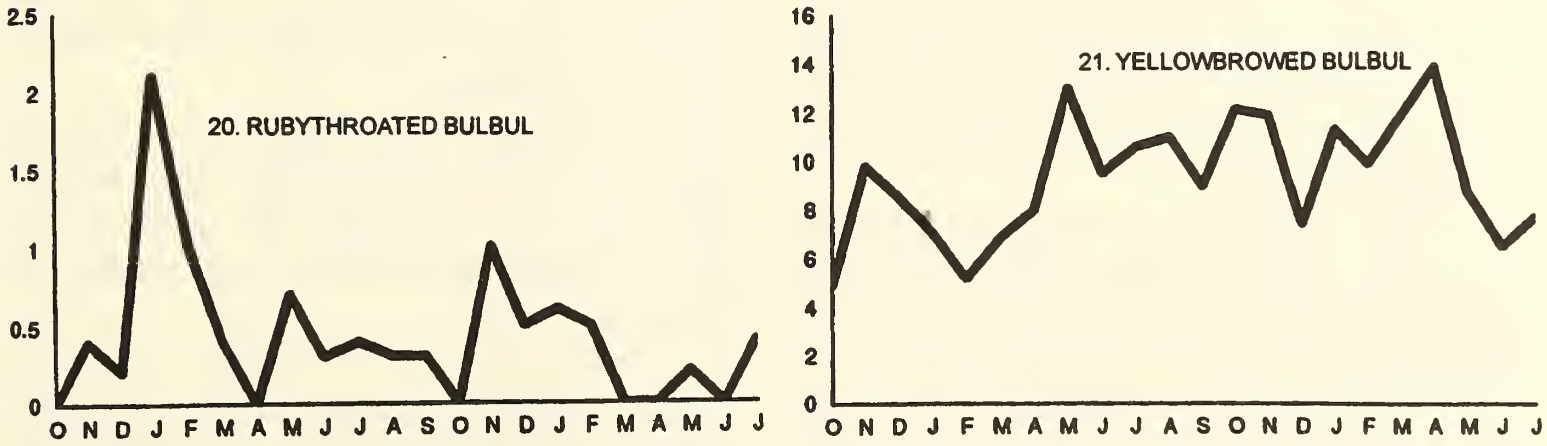


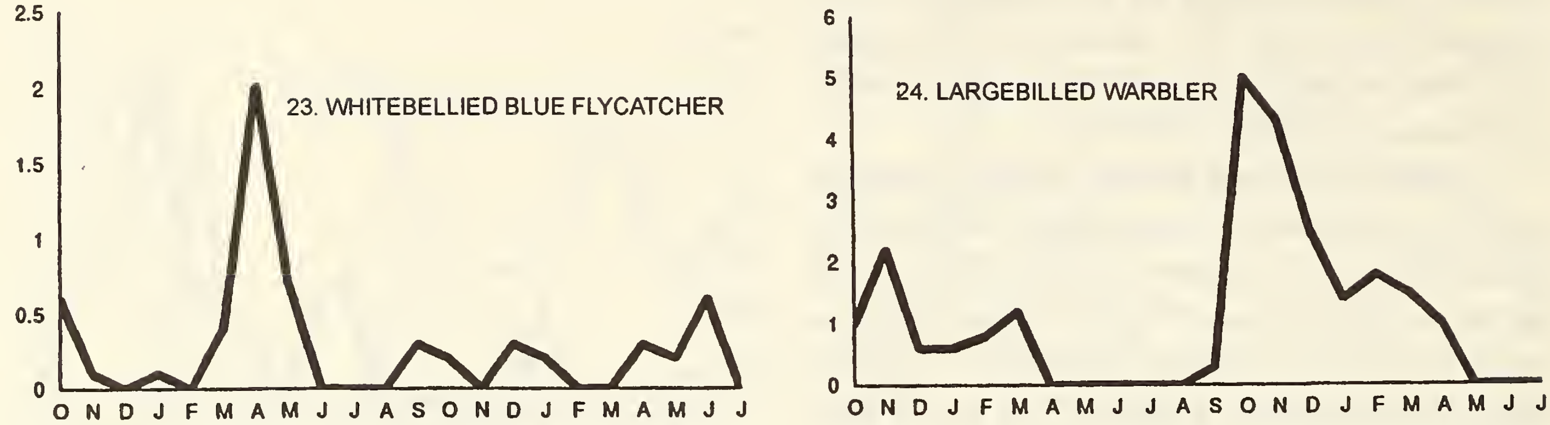
Fig. 22: Monthly mean relative abundance of Scimitar babbler along a 1-km transect through the evergreen forests of Karian Shola, Top Slip, between October 1991 and July 1993. X-axis (abscissa) represents months; Y-axis (ordinate) represents mean number of encounters per kilometre.

Black Bulbul: Common in the highlands beyond *c* 1000 m. Uncommon in Top Slip area, and rare in the foothills. Below 1000 m, the birds were seen mainly at *Eucalyptus* blooms (November-December), to which they show a particular preference. Altitudinal movements obviously governed by flowering of trees.

Slatyheaded Scimitar Babbler:



Figs. 20-21: Monthly mean relative abundances of two species of bulbuls along a 1-km transect through the evergreen forests of Karian Shola, Top Slip, between October 1991 and July 1993. X-axis (abscissa) represents months; Y-axis (ordinate) represents mean number of encounters per kilometre.



Figs. 23-24: Monthly mean relative abundances of two species of forest birds along a 1-km transect through the evergreen forests of Karian Shola, Top Slip, between October 1991 and July 1993. X-axis (abscissa) represents months; Y-axis (ordinate) represents mean number of encounters per kilometre.

Common. Difficult to see owing to dense habitat and shy habits, but often heard. Sporadically recorded at the census trail, mostly in the secondary growth at the edge (Fig. 22). Recorded around Top Slip and at higher elevations (Grass Hills). Rare or absent in the foothills.

Rufousbellied Babbler: Rare, but perhaps more common than they appear, in the foothills scrub and deciduous forests. A flock once seen near Top Slip on 21.v.93.

Wynaad Laughing Thrush: Uncommon. Large parties of 15-30 individuals seen erratically in the secondary growth and bamboo forests around Top Slip. Disappears for a few months only to reappear in big flocks for a few days before vanishing again. Apparently nomadic, with no clear seasonal movement patterns. Parent seen feeding a begging, fledged chick on 8.iii.93. Replaced by the Whitebreasted Laughing Thrush in higher elevations.

Whitebreasted Laughing Thrush: Uncommon above 1400m. Absent at lower elevations. Seen from about Kavarakkal, 14 kms from Valparai upwards through Grass Hills.

Brownbreasted Flycatcher: Rare. Seen thrice, in winter: 2.xi.91, 12.xii.92 and 18.ii.93, all in Karian Shola.

Black-and-Orange Flycatcher: Rare. One male seen in Kadamparai Shola (altitude: 1355m, off 36th hair-pin bend in the Pollachi-Valparai road, 11 kms from Valparai). Not recorded elsewhere despite careful searches.

Whitebellied Blue Flycatcher: Uncommon. Occurs all year in low densities in evergreen forests (Fig. 23). Easier heard than seen.

Broadtailed Grass Warbler: Rare. Two pairs seen and heard singing continuously in Grass Hills, 11.v.92. The mouth, which can be seen while singing, is distinctly *black*, as mentioned under museum diagnosis by Ali and Ripley (1987). Not recorded in the same area in February 93 despite intensive search, suggesting that the species can be detected easily only while it sings. Song is similar to that described by Nichols (1937). Ali and Ripley (1987) indicate that the species is "on the whole rather scarce". Requires monitoring.

Thickbilled Warbler: Rare. Two records: Two seen in brush by Parambikulam lake on 13.iv.92; one near Top Slip on 13.xii.92. On both occasions, the bright orange mouth was conspicuous.

Tickell's Leaf Warbler: Common. Regular member of mixed hunting flocks in winter at Kadambarai Shola (1355m). Not recorded at Top Slip.

Largebilled Warbler: Common. Winter visitor. Heard more often than seen, in evergreen forest undergrowth. 2-5 individuals usually

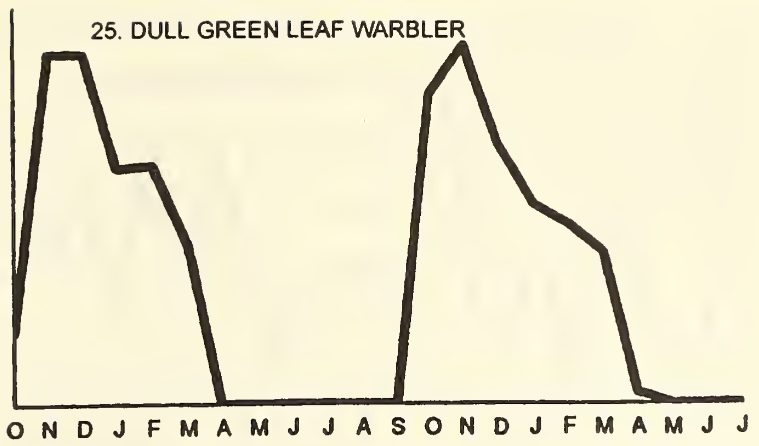


Fig. 25: Monthly mean relative abundance of Dull green leaf-warbler along a 1-km transect through the evergreen forests of Karian Shola, Top Slip, between October 1991 and July 1993. X-axis (abscissa) represents months; Y-axis (ordinate) represents mean number of encounters per kilometre.

recorded in a 1-km walk through appropriate habitat (Fig. 24). The average number of birds encountered between September and April of 92-93 was 2.3/km (N=33 counts). The distinctive, 5-noted song heard occasionally in October and April, i.e., immediately after autumn migration, and before spring migration.

Dull Green Leaf Warbler: Common. Occurs at relatively high densities in winter in evergreen forest (Fig. 25). Between 5-10 individuals recorded per km (average for October-April 92-93 was 5.5 birds/km, N=29 counts). Wintering densities estimated at 2-3 birds/hectare elsewhere in the Western Ghats (Madhusudan Katti, pers. comm.)

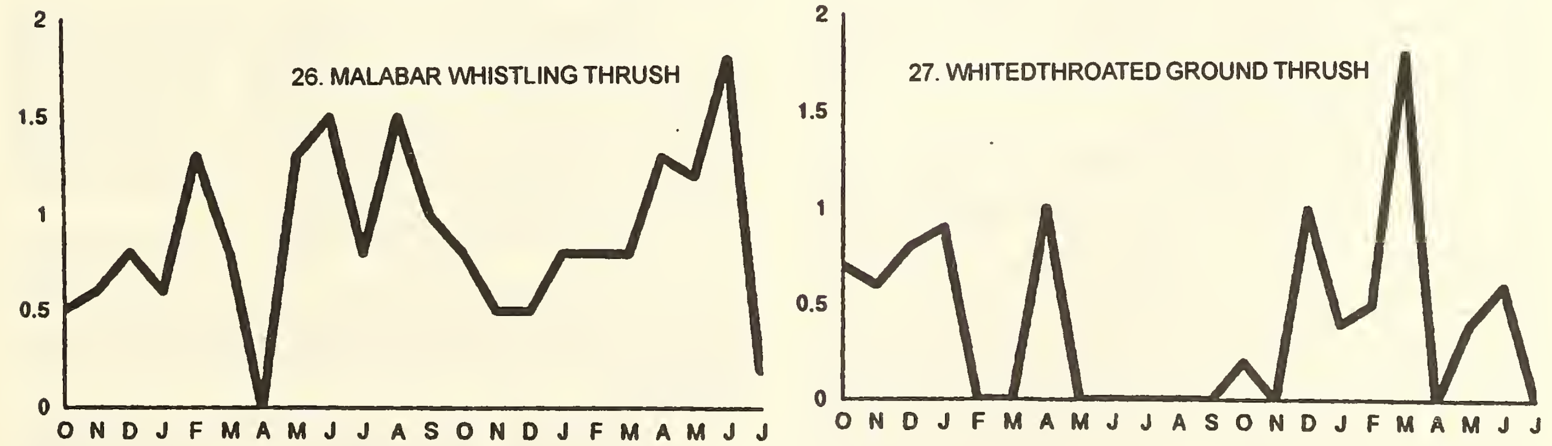
Large Crowned Leaf Warbler: Common winter visitor to the higher altitudes (Valparai Plateau). 10-15 birds seen invariably foraging with mixed hunting flocks. Recorded in Kadambarai Shola and Akkamalai forests. Uncommon in Top Slip forests, where it was seen a few times in January-February 93.

Blue Chat: Rare. A pair seen in mixed bamboo forests near Top Slip on 8.iii.93. Curiously, not recorded at higher altitudes despite intensive searches for this species, possibly overlooked.

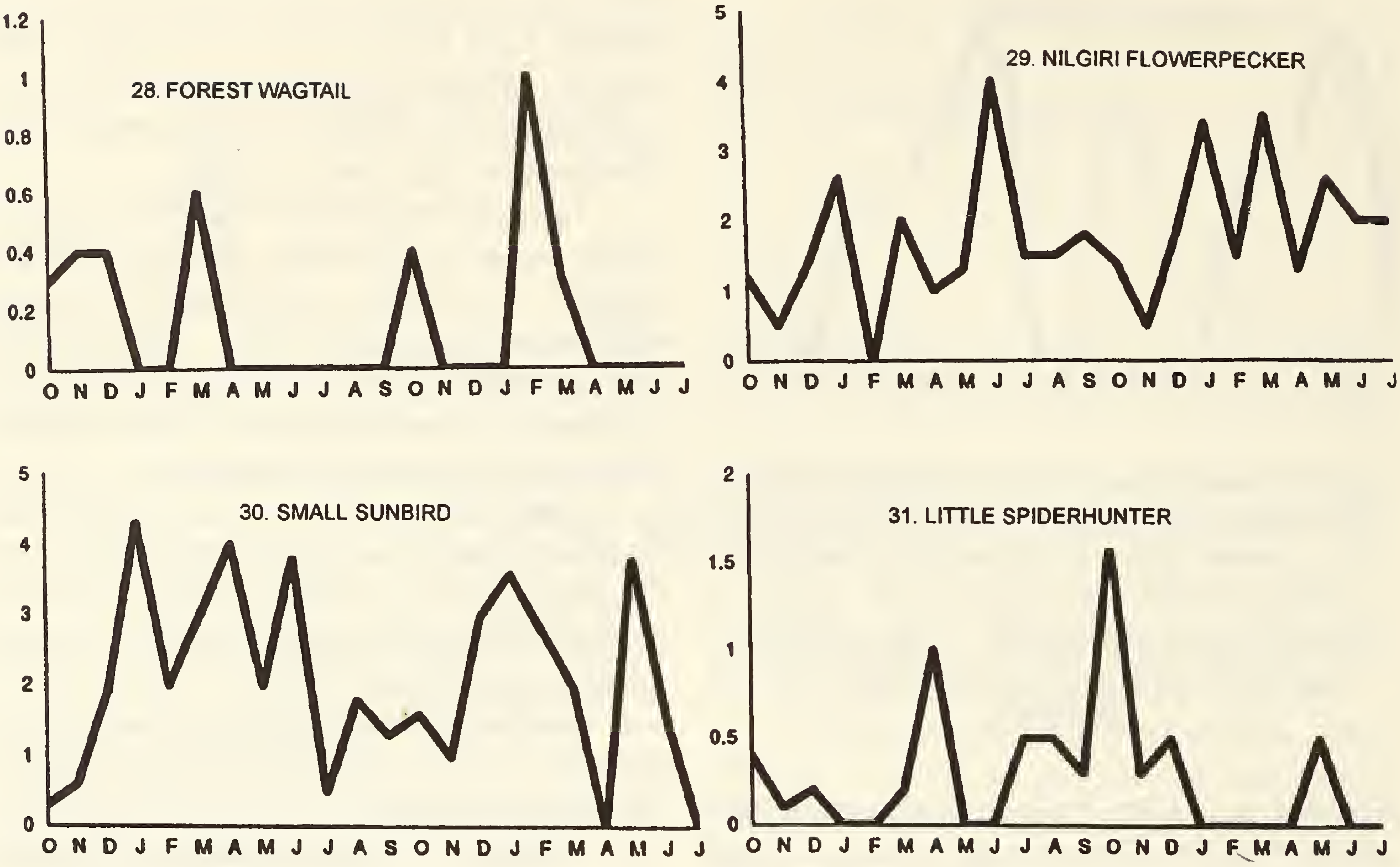
Blueheaded Rock Thrush: Rare. Winter visitor. Two records, both female, near Top Slip: 27.i.93 and 28.iii.93.

Malabar Whistling Thrush: Common. Very vocal, thus easily detectable during the onset of southwest monsoon (June), which probably accounts for the peaks in relative abundance (Fig. 26).

Whitethroated Ground Thrush: Common. Not easily recorded during the breeding season in May-September, when the birds are seclusive (Fig. 27). Courtship display



Figs. 26-27: Monthly mean relative abundances of two species of thrushes along a 1-km transect through the evergreen forests of Karian Shola, Top Slip, between October 1991 and July 1993. X-axis (abscissa) represents months; Y-axis (ordinate) represents mean number of encounters per kilometre.



Figs. 28-31: Monthly mean relative abundances of four species of forest birds along a 1-km transect through the evergreen forests of Karian Shola, Top Slip, between October 1991 and July 1993. X-axis (abscissa) represents months; Y-axis (ordinate) represents mean number of encounters per kilometre.

observed on 2.iii.92: "Male sits bolt upright near female, head bowed, bill pointing directly down, wings drooping, uttering an endless delightful series of warbling chirruping notes...same display and vocalisations in progress at same site 1.25 hours later" (Author's field notes). This is almost the same sequence described by Betts, as cited in Ali and Ripley (1987).

Nilgiri, or Smallbilled, Thrush: Rare. Seen once, 23.x.1991 in Karian Shola. Seen here in January 1988 by some competent birders (J.N.Prasad and S. Karthik, pers. comm.). Ali and Ripley (1987) state that this species is uncommon, and place its altitudinal range at 600-2100 m in these hills. The fact that it was noted just once despite specific and careful scrutiny at various elevations in the appropriate habitat is intriguing and a cause for concern.

Blackbird: Rare. Maybe commoner at higher elevations, but seen only in the first (11.v.92) of the two Grass Hills surveys. Noted twice in the Top Slip area, November 91 and December 92, both sightings in evergreen and mixed deciduous forests.

Nilgiri Pipit: Common. Only in Grass Hills. Call: a distinctive, soft *sink....sink*, hitherto unrecorded in the literature (see Ali and Ripley 1987). Commonly heard in May 92, in the middle of the breeding season.

Forest Wagtail: Uncommon. Winter visitor (September-March). Seen in very small numbers inside evergreen forests (Fig. 28) around Top Slip.

Nilgiri, or Plaincoloured, Flowerpecker: Common. Encountered regularly (Fig. 29) in evergreen forests ($\bar{x}$=1.6; N=136 counts) and in mixed forests. Almost always noted in large trees with clumps of mistletoe. Nests discovered

September 91 and February 92 in Top Slip.

Small Sunbird: Common ($\bar{x}$=2.07/km; N=136 counts). Fluctuation in local abundance probably synchronised with flower-ing of forest vegetation (Fig. 30). Nests discovered in Karian Shola and in Kadambarai January 93.

Little Spiderhunter: Common. Year-round denizen of evergreen forests (Fig. 31), with local movements probably governed by flowering phenologies. Many signs of nesting evident in the summer months (February-May).

White-eye: Common above *c* 1000 m; Rare in Top Slip, where a flock was seen once, 20.ix.92.

Rufousbellied Munia: Uncommon. Seen in evergreen forest clearings off and on, suggesting local movements. Occurs from about 750 m up to 1350 m (Kadambarai). Not recorded in Grass Hills.

Common Rosefinch: Rare. Winter visitor. Flock of 4-5 birds, mostly brown, one pink-plumaged, seen in Karian Shola from 7-9 January 93.

SIGNIFICANT SPECIES THAT WERE NOT RECORDED DESPITE CAREFUL SEARCHES

Legge's Baza *Aviceda jerdoni*: This forest raptor has always been considered a rare resident of evergreen forests south of *c* 12° N latitude, between 150 and 900 m altitude (Ali and Ripley 1987). The fact that it was unrecorded in these two years, highlights its rare status. With much of its optimal habitat having been destroyed in the past two decades, the species may be threatened. A comprehensive survey for this forest raptor is necessary throughout the Ghats to ascertain its current status and conservation issues.

Malabar Pied Hornbill *Anthracoceros coronatus*: Kinloch (1921) recorded this species as "very common" in the Nelliampathies. Sivaprasad (pers. comm.) reported seeing it in the Nelliampathies in the 1990's. Sugathan (pers. comm.) netted and banded an individual in Parambikulam. The undoubted scarcity of the species in the Anaimalais can only be explained by its preference to moister facies than those available in the rainshadow areas of the east. Nevertheless, the species should be monitored carefully owing to its seemingly increasing scarcity.

Fantail Warbler *Cisticola exilis*: Ali and Ripley (1987) record this species as a "common resident" in the southern hills "above 900 m". Intensive hunts in several localities with appropriate grassy habitat above 900 m (Pandaravarai, Umayamalai, Vengoli, Pamban Malai, Kozhumbu Malai, Karimala Gopuram) proved futile. Grass Hills (*c.* 2200 m), with its vast expanse of grassy undulating terrain seems its ideal habitat. Also, Perunkundru (*c* 1500 m), a grass covered peak known for its Nilgiri Tahr, should provide excellent haunts for this warbler.

Whitebellied Shortwing *Brachypteryx major*: Ali and Ripley (1987) indicate that there are two races of this shortwing in south India, separated by the Palghat Gap. The Grass Hills area, with its abundant dense sholas, should offer optimal habitat for the whitebellied race (*B. m. albiventris*). Presumably, this bird was overlooked during this project owing to its shy and secretive habits. All the surveys to the Valparai Plateau and Grass Hills failed to yield a sighting. There are two specimens in the BNHS collection, both obtained above 1800 m in the Palni Hills (Abdulali 1987).

Woodcock *Scolopax rusticola*: The absence of any sighting of this species in two consecutive winters in ostensibly appropriate country should be considered noteworthy in the light of the statement of Ali and Ripley (1987) more than 20 years ago that "the clearing away of forests for potato and tea cultivation in the last forty years has progressively reduced its abundance in many of its best known habitats". With the continuing destruction of forests in the south Indian hills, it is possible that the situation, of concern as it may have been then, has only deteriorated since. The phasing out of woodcock hunting as a sport, which was popular during the colonial era, has deprived us of an important source of anecdotal information regarding population trends. This calls for an increased surveillance of wintering populations of this and other species of birds in peninsular India.

CONCLUSIONS

Ever since colonial pioneers like Carver Marsh opened up the Anaimalais for tea plantations and lumbering operations in the 1800s, vast areas have been denuded or selectively logged. The findings in this study suggest that despite this severe encroachment, avifaunal species composition was not affected drastically in the Anaimalais. No clear case of local bird extinction could be alleged by comparison with the sketchy historical records. This type of avian resilience has been reported by earlier studies from elsewhere in the Western Ghats (Daniels *et al.* 1990). However, the situation is unstable because destruction continues unabated in the face of increasing need for tea and timber revenue. Over 500 mature rainforest trees were felled in 1992 in Valparai Plateau (Puthuthottam Estate) despite strong protests from environmental groups, and plans are afoot to increase the tea area by 3,350 ha. The lack of quantitative historical data on bird abundance precluded an assessment of the impact of human activities on bird numbers. Since continual human encroachment seems inevitable, there is an urgent need to monitor forest bird populations. It is hoped that this report would instigate the establishment of bird census programmes specifically to monitor forest birds in the Anaimalai Hills and elsewhere in the Western Ghats.

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APPENDIX

Systematic list of the birds recorded in the Anaimalai Hills between August 1991 and July 1993.

Distribution codes: F=Foothills; T=Top Slip area; P=Parambikulam area; V=Valparai Plateau (includes Akkamalai forests); G=Grass Hills. Sholayar and Chalakudy are not included here (see text).

Status codes: C=Common; U=Uncommon; R=Rare; W=Winter visitor; B=Evidence of breeding in the area (nests or newly fledged chick(s) recorded). For a further explanation of the status codes, see "Methods" section. Asterisk (*) by species name indicates more details furnished in text. An "e" superscripted by species name indicates endemic to Western Ghats.

No.	Species	Status	Dist.
1	Little Grebe *Tachybaptus ruficollis*	R	F
2	Large Cormorant *Phalacrocorax carbo*	U	P
3	Little Cormorant *P. niger*	U	P
4	Darter *Anhinga rufa*	U	P
5	Grey Heron *Ardea cinerea*	U	F
6	Pond Heron *Ardeola grayi*	U	F,P
7	Cattle Egret *Bubulcus ibis*	U	F,V
8	Large Egret *Ardea alba*	U	F
9	Smaller Egret *Egretta intermedia*	U	F
10	Little Egret *E. garzetta*	U	P
11	Malay Bittern* *Gorsachius melanolophus*	R	T,P
12	Whitenecked Stork *Ciconia episcopus*	R	F
13	Shoveller *Anas clypeata*	R,W	T(flt)
14	Blackwinged Kite *Elanus caeruleus*	U	T,G
15	Blackcrested Baza* *Aviceda leuphotes*	R	T

APPENDIX (*contd.*)

No.	Species	Status	Dist.
16	Honey Buzzard *Pernis ptilorhyncus*	U,B	T,P
17	Pariah Kite *Milvus migrans*	C,B	towns
18	Brahminy Kite *Haliastur indus*	U,B	F,T
19	Shikra *Accipiter badius*	U,B	T
20	Crested Goshawk★ *A. trivirgatus*	R	T,V
21	Besra Sparrowhawk★ *A. virgatus*	R	T
22	Buzzard *Buteo buteo*	U,W	F
23	Crested Hawk-eagle★ *Spizaetus cirrhatus*	U	F,T
24	White-eyed Buzzard-Eagle *Butastur teesa*	R	F
25	Booted Hawk-Eagle *Hieraaetus pennatus*	U,W	F,T
26	Rufousbellied Hawk-Eagle★ *H. kienerii*	R	T
27	Black Eagle *Ictinaetus malayensis*	U	T,P
28	Greyheaded Fishing-Eagle★ *Ichthyophaga icthyaetus*	R,B	P
29	Short-Toed Eagle *Circaetus gallicus*	R	F
30	Crested Serpent Eagle *Spilornis cheela*	U	F,T,P
31	Osprey★ *Pandion haliaetus*	R,W	F,P
32	Shaheen Falcon★ *Falco peregrinus*	R,B	F,T
33	Kestrel *Falco tinnunculus*	U	F,T
34	Grey Partridge *Francolinus pondicerianus*	U?	F
35	Jungle Bush Quail★ *Perdicula asiatica*	R?	T
36	Red Spurfowl★ *Galloperdix spadicea*	U,B	T,P
37	Grey Junglefowl★ *Gallus sonneratii*	C,B	T,P,V
38	Common Peafowl *Pavo cristatus*	U	F
39	Whitebreasted Waterhen *Amaurornis phoenicurus*	R,B	T,V
40	Redwattled Lapwing *Vanellus indicus*	U	T,P
41	Wood Sandpiper *Tringa glareola*	R,W	T
42	Common Sandpiper *T. hypoleucos*	R,W	F
43	Common Tern *Sterna hirundo*	U,W	P
44	Pompadour Pigeon★ *Treron pompadora*	C,B	T,P,V
45	Imperial Pigeon★ *Ducula badia*	C,B?	T,P,V
46	Blue Rock Pigeon *Columba livia*	U	T
47	Nilgiri Woodpigeon★,e *C. elphinstonii*	R	T
48	Ring Dove *Streptopelia decaocto*	U	F
49	Spotted Dove *S. chinensis*	U	F
50	Little Brown Dove *S. senegalensis*	U	F
51	Emerald Dove★ *Chalcophaps indica*	U,B	T,P,V
52	Blossomheaded Parakeet★ *Psittacula cyanocephala*	(see text)	T,P
53	Bluewinged Parakeet★,e *P. columboides*	C	T,P
54	Indian Lorikeet★ *Loriculus vernalis*	C	T,P,V
55	Pied Crested Cuckoo★ *Clamator jacobinus*	R	F,T
56	Large Hawk Cuckoo★ *Cuculus sparverioides*	R,W	T
57	Common Hawk Cuckoo *C. varius*	U	T
58	Bay Banded Cuckoo★ *Cacomantis sonneratii*	R?	T
59	Koel *Eudynamis scolopacea*	U	T
60	Small Greenbilled Malkoha *Rhopodytes viridirostris*	U	T

APPENDIX (*contd.*)

No.	Species	Status	Dist.
61	Sirkeer Cuckoo★ *Taccocua leschenaultii*	R	F,T
62	Bay Owl★ *Phodilus badius*	R	T,P
63	Scops Owl★ *Otus scops*	U?	T
64	Collared Scops Owl *O. bakkamoena*	R	F,T
65	Great Horned Owl *Bubo bubo*	R	F,T
66	Forest Eagle Owl★ *B. nipalensis*	R	T
67	Brown Fish Owl★ *B. zeylonensis*	U	T
68	Jungle Owlet *Glaucidium radiatum*	U	T
69	Brown Hawk-Owl★ *Ninox scutulata*	U	T
70	Spotted Owlet *Athene brama*	C	F
71	Ceylon Frogmouth★ *Batrachostomus moniliger*	R,B	T
72	Great Eared Nightjar★ *Eurostopodus macrotis*	R	T,P
73	Jungle Nightjar★ *Caprimulgus indicus*	R	F,T
74	Longtailed Nightjar★ *C. macrurus*	U	T
75	Edible-Nest Swiftlet★ *Collocalia unicolor*	U	T,G
76	Large Brownthroated Spinetail Swift★ *Chaetura gigantea*	C	T,P
77	Whiterumped Spinetail★ *C. sylvatica*	R	T
78	Alpine Swift★ *Apus melba*	R	T
79	House Swift *A. affinis*	U	T
80	Palm Swift *Cypsiurus parvus*	C	F,T
81	Crested Tree Swift *Hemiprocne longipennis*	C	T,P,V
82	Malabar Trogon★ *Harpactes fasciatus*	U,B	T,P,V
83	Pied Kingfisher *Ceryle rudis*	U	F,P
84	Whitebreasted Kingfisher *Halcyon smyrnensis*	U	F,T
85	Chestnut headed Bee-Eater *Merops leschenaultii*	C	T,P,V,G
86	Green Bee-Eater *M. orientalis*	C	F
87	Bluebearded Bee-Eater★ *Nyctyornis athertoni*	R,B	T
88	Indian Roller *Coracias benghalensis*	U	F,T
89	Broadbilled Roller★ *Eurystomus orientalis*	U	T
90	Hoopoe *Upupa epops*	U	F,T
91	Malabar Grey Hornbill★,e *Tockus griseus*	C,B	T,P,V
92	Great Pied Hornbill★ *Buceros bicornis*	U,B	F,T,P,V
93	Large Green Barbet *Megalaima zeylanica*	U	F
94	Small Green Barbet★ *M. viridis*	C	T,P,V
95	Crimsonthroated Barbet★ *M. rubricapilla*	C	T,P,V
96	Crimsonbreasted Barbet *M. haemacephala*	U	F,T
97	Speckled Piculet★ *Picumnus innominatus*	?	V
98	Rufous Woodpecker★ *Micropternus brachyurus*	R	T
99	Yellownaped Woodpecker *Picus chlorolophus*	U,B	T
100	Threetoed Goldenbacked Woodpecker *Dinopium javanense*	U	T,V
101	Great Black Woodpecker★ *Dryocopus javensis*	U,B	T

APPENDIX (*contd.*)

No.	Species	Status	Dist.
102	Pied Woodpecker *Picoides mahrattensis*	R	T
103	Heartspotted Woodpecker★ *Hemicircus canente*	U,B	T,P,V
104	Large Goldenbacked Woodpecker *Chrysocolaptes lucidus*	U,B	T,V
105	Pigmy Woodpecker *Picoides nanus*	U	F,T
106	Indian Pitta★ *Pitta brachyura*	R,W	T,V
107	Bush Lark *Mirafra assamica*	U	F
108	Ashycrowned Finchlark *Eremopterix grisea*	R	F
109	Eastern Skylark *Alauda gulgula*	U	G
110	Dusky Crag Martin *Hirundo concolor*	U,B?	P
111	Common Swallow *H. rustica*	C,W	F,T
112	House Swallow★ *H. tahitica*	R	G
113	Redrumped Swallow *H. daurica*	U,B?	F,T,P
114	Rufousbacked Shrike *Lanius schach*	R	F,T,V
115	Brown Shrike *L. cristatus*	U	F,T
116	Golden Oriole *Oriolus oriolus*	R,W	F,T,V
117	Blacknaped Oriole★ *O. chinensis*	R,W	T
118	Blackheaded Oriole *O. xanthornus*	U	F,T
119	Black Drongo *Dicrurus adsimilis*	U	F,T
120	Grey Drongo *D. leucophaeus*	U,W	T,V
121	Whitebellied Drongo *D. caerulescens*	U,W	F,T
122	Bronze Drongo *D. aeneus*	C,B	T
123	Haircrested Drongo★ *D. hottentottus*	R?	T
124	Greater Racket-tailed Drongo★ *D. paradiseus*	C	T,P,V
125	Ashy Swallow-shrike *Artamus fuscus*	C	F
126	Greyheaded Myna *Sturnus malabaricus*	U	F
-	Greyheaded Myna (Whiteheaded race)	C	T,P
127	Blackheaded Myna *Sturnus pagodarum*	R	T
128	Common Myna *Acridotheres tristis*	C	F,T
129	Jungle Myna *A. fuscus*	C	V,930m+
130	Hill Myna★ *Gracula religiosa*	C	T,P,V
131	Indian Treepie *Dendrocitta vagabunda*	U	T
132	Whitebellied Treepie★ *D. leucogastra*	C,B	T,P
133	House Crow *Corvus splendens*	C	T,P
134	Jungle Crow *C. macrorhynchos*	C	T,P
135	Pied Flycatcher-Shrike *Hemipus picatus*	U,B	T,P,V
136	Large Woodshrike *Tephrodornis virgatus*	U,B	T,P
137	Common Woodshrike *T. pondicerianus*	U	F
138	Large Cuckoo-Shrike *Coracina novaehollandiae*	U	T,P
139	Blackheaded Cuckoo-Shrike *C. melanoptera*	R	T,P
140	Scarlet Minivet *Pericrocotus flammeus*	C,B	T,P,V
141	Small Minivet *P. cinnamomeus*	U	F,T
142	Common Iora *Aegithina tiphia*	C	F,T
143	Goldfronted Chloropsis *Chloropsis aurifrons*	C	T,P
144	Fairy Bluebird★ *Irena puella*	C	T,P,V
145	Greyheaded Bulbul★,[e] *Pycnonotus priocephalus*	R	T
146	Rubythroated Bulbul★ *P. melanicterus*	U	T,P
147	Redwhiskered Bulbul *P. jocosus*	U	F,T
148	Redvented Bulbul *P. cafer*	C	F

APPENDIX (*contd.*)

No.	Species	Status	Dist.
149	Yellowthroated Bulbul* *P. xantholaemus*	R	V
150	Whitebrowed Bulbul *P. luteolus*	U	F,T
151	Yellowbrowed Bulbul* *Hypsipetes indicus*	C,B	T,P,V
152	Black Bulbul* *H. madagascariensis*	(see text)	T,P,V
153	Spotted Babbler *Pellorneum ruficeps*	C	F,T,P, V
154	Slatyheaded Scimitar Babbler* *Pomatorhinus horsfieldii schisticeps*	C,B	T,P,V,G
155	Rufousbellied Babbler* *Dumetia hyperythra*	R?	F,T
156	Blackheaded Babbler *Rhopocichla atriceps*	U	T,P,V
157	Rufous Babbler^{e} *Turdoides subrufus*	U	T,P
158	Jungle Babbler *T. striatus*	C,B	T,P
159	Whiteheaded Babbler *T. affinis*	C	F
160	Wynaad Laughing Thrush* *Garrulax delesserti*	U,B	T
161	Whitebreasted Laughing Thrush^{*,e} *G. jerdoni*	U	V,G
162	Quaker Babbler *Alcippe poioicephala*	C	T,P,V
163	Brown Flycatcher *Muscicapa latirostris*	U,W	F,T,V
164	Brownbreasted Flycatcher* *M. muttui*	R,W	T
165	Rufoustailed Flycatcher *M. ruficauda*	U,W	T,V
166	Black & Orange Flycatcher^{*,e} *M. nigrorufa*	R	V
167	Whitebellied Blue Flycatcher^{*,e} *M. pallipes*	U	T,P
168	Bluethroated Flycatcher *M. rubeculoides*	U,W	F,T,P
169	Tickell's Blue Flycatcher *M. tickelliae*	U	T,P
170	Verditer Flycatcher *M. thalassina*	U	T,P,V
171	Nilgiri Flycatcher^{e} *M. albicaudata*	C	V,G
173	Greyheaded Flycatcher *Culicicapa ceylonensis*	C,B	V,G
174	Paradise Flycatcher *Terpsiphone paradisi*	U,W	F,T,P,V
175	Blacknaped Flycatcher *Hypothymis azurea*	C	T,P,V
176	Str. Fantail Warbler *Cisticola juncidis*	U	F
177	Franklin's Wren-Warbler *Prinia hodgsonii*	C,B	F,T,P
178	Jungle Wren-Warbler *P. sylvatica*	U	F
179	Tailor Bird *Orthotomus sutorius*	U	F,T
180	Broadtailed Grass Warbler^{*,e} *Schoenicola platyura*	R	G
181	Thickbilled Warbler* *Acrocephalus aedon*	R,W	P
182	Reed Warbler *Acrocephalus dumetorum*	U,W	F,T,V
183	Tickell's Leaf Warbler* *Phylloscopus affinis*	C,W	V
184	Largebilled Leaf Warbler* *P. magnirostris*	C,W	T,P,V
185	Dull Green Leaf Warbler* *P. trochiloides*	C,W	T,P,V
186	Large Crowned Leaf Warbler* *P. occipitalis*	(see text)	T,P,V
187	Indian Blue Chat* *Erithacus brunneus*	R,W	T
188	Magpie Robin *Copsychus saularis*	U	T,P
189	Shama *C. malabaricus*	U	T
190	Pied Bush Chat *Saxicola caprata*	C	V
191	Indian Robin *Saxicoloides fulicata*	U	F

APPENDIX (*contd.*)

No.	Species	Status	Dist.
192	Blueheaded Rock Thrush★ *Monticola cinclorhynchus*	R,W	T
193	Malabar Whistling Thrush★ *Myiophonus horsfieldii*	C	T,P,V
194	Whitethroated Ground Thrush★ *Zoothera citrina*	C	T,P
195	Nilgiri or Smallbilled Thrush★ *Z. dauma*	R	T
196	Blackbird★ *Turdus merula*	R?	T,G
197	Grey Tit *Parus major*	U	T,P,V
198	Yellowcheeked Tit *P. xanthogenys*	C	V
199	Velvetfronted Nuthatch *Sitta frontalis*	U	T,V
200	Indian Pipit *Anthus novaeseelandiae*	U	T
201	Nilgiri Pipit★,e *A. nilghiriensis*	C	G
202	Forest Wagtail★ *Motacilla indica*	U,W	T,P
203	Grey Wagtail *M. cinerea*	U,W	T,P,V
204	Large Pied Wagtail *M. maderaspatensis*	U	F,T
205	Thickbilled Flowerpecker *Dicaeum agile*	U	T
206	Tickell's Flowerpecker *D. erythrorhychos*	R	F
207	Nilgiri Flowerpecker★ *D. concolor*	C,B	F,T,P,V
208	Purplerumped Sunbird *Nectarinia zeylonica*	U,B	F,T
209	Small Sunbird★,e *N. minima*	C,B	T,P,V
210	Loten's Sunbird *N. lotenia*	R	T
211	Purple Sunbird *N. asiatica*	C	F
		U	T
212	Little Spiderhunter★ *Arachnothera longirostris*	C,B	T,P,V
213	White-eye★ *Zosterops palpebrosa*	C	V
		R	T
214	House Sparrow *Passer domesticus*	C	T,V
215	Whitethroated Munia *Lonchura malabarica*	R	F
216	Whitebacked Munia *L. striata*	R,B	T
217	Rufousbellied Munia★ *L. kelaarti*	U	T,P,V
218	Common Rosefinch★ *Carpodacus erythrinus*	R	T

HABITAT, HUNTING AND CONSERVATION OF RUPICAPRINES IN MIZORAM, NORTHEAST INDIA[1]

CHARUDUTT MISHRA, T.R. SHANKAR RAMAN[2] AND A.J.T. JOHNSINGH[3]

(*With one text-figure*)

Key words: Serow, goral, slash-and-burn shifting cultivation, habitat ecology, wildlife management

A conservation status survey of serow *Nemorhaedus sumatraensis* and Himalayan goral *N. goral* was conducted in three protected areas and nearby villages in Mizoram state. Serow occurred in all three areas (Dampa Tiger Reserve, Murlen National Park, Phawngpui Wildlife Sanctuary) but there was no evidence of goral in Dampa. Goral mainly used steep grassland areas adjoining cliffs. The serow used areas where primary or secondary forests bordered steep slope vegetation along cliffs. The ratio of serow to goral skulls among trophies accumulated by local hunters was 4.2:1, reflecting greater relative abundance of serow in the recent past. While both species are hunted, serow are also likely to suffer from habitat loss due to shifting cultivation. Protection of key habitats such as cliffs with adjoining forests and grasslands and strengthening vigilance and monitoring efforts are suggested.

INTRODUCTION

Three species of rupicaprines, serow *Nemorhaedus sumatraensis*; Himalayan goral *N. goral,* and red goral *N. baileyi,* occur along the Himalayan mountain chain and the northeastern hills in India (Groves and Grubb 1985). Information pertaining to their status and distribution is nevertheless scarce, particularly in northeast India. This region, identified as one of the most biogeographically important conservation areas in the country (Rodgers and Panwar 1988), is also among the top 18 biodiversity 'hotspots' in the world (Myers 1988, 1990). Currently, the diverse flora and fauna of this region are threatened by logging, shifting cultivation or *jhum,* and illegal hunting by local communities (Johnsingh 1985, Choudhury 1987, Myers 1988, Rodgers and Panwar 1988, Katti 1992). This survey was undertaken to assess the conservation status of rupicaprines in the state of Mizoram in northeast India, one of the least surveyed and documented wildlife areas in the country (Rodgers and Panwar 1988). Even reliable information on presence or absence of species, including birds and large mammals, was lacking from Mizoram until recent surveys and studies (Rai and Johnsingh 1993, Mishra *et al.* 1994, Raman 1995, Raman *et al.* 1995a, 1995b).

STUDY AREA

Survey sites: The survey was conducted in three protected areas of Mizoram: Dampa Tiger Reserve in western Mizoram, Murlen National Park, and Phawngpui Wildlife Sanctuary, both in eastern Mizoram. Dampa Tiger Reserve (23° 20'-23° 47' N, 92° 15'-92° 30' E) has an area of 500 km^2 and ranges altitudinally between 250 and 1,100 m above msl level. The vegetation consists of tropical wet evergreen forest in the valleys and semi-evergreen forest close to the ridges. Large areas

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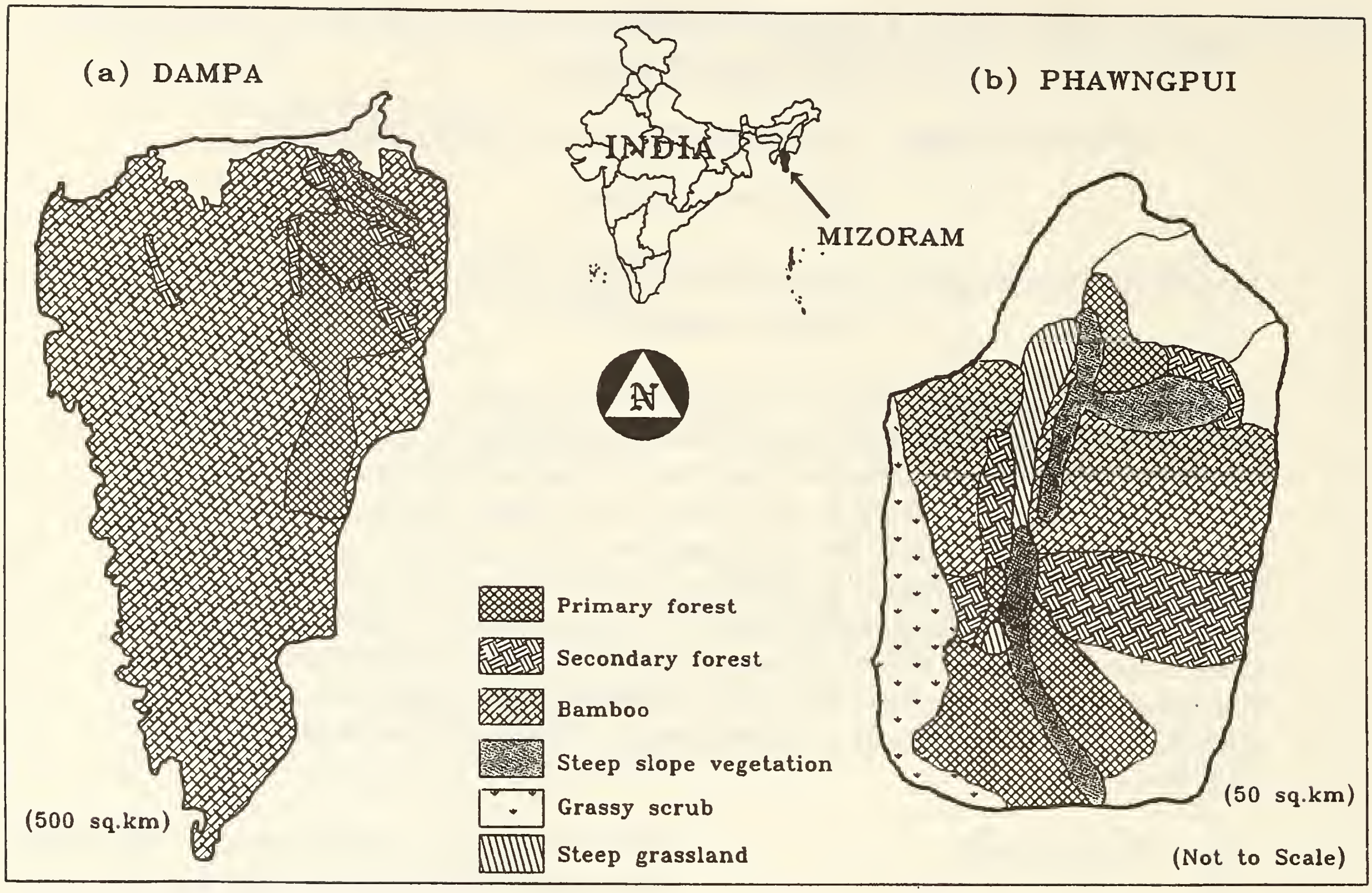

Fig. 1: Vegetation maps of Dampa and Phawngpui Wildlife Sanctuaries, Mizoram, North-East India.

occur under bamboo (mainly *Melocanna bambusoides*), which is secondary vegetation in areas previously cleared for shifting cultivation or *jhum*. Murlen National Park (*c.* 23° 64' N and 93° 29' E; 200 km^2) and Phawngpui Wildlife Sanctuary (*c.* 22° 62' N and 93° 02' E; 50 km^2) which are at higher altitudes (*c.* 1,200 to 2,100 m), are covered with sub-tropical broadleaved hill forests with oaks (*Quercus* spp.) as characteristic species (Champion and Seth 1968). All three areas have long (> 3 km) chains of cliffs. A narrow belt of vegetation occurs along these cliffs (steep-slope vegetation; Fig. 1) which is richer in grass cover and has a lower tree density than surrounding areas. Steep, open grasslands occur along the cliffs in Phawngpui, with tree cover along the *nullahs* and gullies. The areas below the cliffs are generally covered with well-wooded broad-leaved forests within the protected areas, but mostly by bamboo outside.

People and land-use: The human population of Mizoram is predominantly tribal, and over 60% of the people are dependent on *jhum* for subsistence (Singh 1995). The Mizos (the name covers several tribal communities such as the *Ralte, Pachuau, Lushai,* and *Lai*) have a long tradition of hunting similar to many other hill communities in south and south-east Asian forests. We have observed houses of several hunters in villages adorned with trophies of serow, goral, macaque, bear, wild pig, deer, and hornbill.

The State has seen dramatic changes related to its human population over the last century. The population had reached almost 700,000 by 1991, an 850% increase since the beginning of the century. The current population density is over 33 per km^2 (Singh 1995). During this period, the literacy rate increased to 82.3% and most of the people, originally animists, became Christian due to missionary activities. Rapid changes follow modernisation and development activities and, as a result, over 46% of the population lives in towns and cities today. Nevertheless, in remote rural areas, traditional lifestyles persist more or less intact and largely revolve around activities pertaining to *jhum*, hunting, and the village community.

Jhum is the primary occupation of the majority of people in Mizoram. Much of the surveyed protected area has undergone *jhum* in the past, as indicated by the large areas with secondary bamboo vegetation (Fig. 1a and b). Description of *jhum* activities and vegetation succession are available in Ramakrishnan (1992), Raman (1995), and Raman *et al.* (in press). With the loss of habitat associated with *jhum* and increasing population, hunting is not sustainable any more. In the vicinity of towns and villages, even the usually common birds and mammals are very scarce.

METHODS

The survey was conducted between 24th December 1993 and 18th January 1994. Different forest types were traversed on foot, and evidence (faecal pellets, dung piles, tracks) and direct sightings of rupicaprines were recorded. Rough vegetation maps of Dampa and Phawngpui were sketched on 1:50,000 contour maps with the aid of a compass to get an idea of the potential habitat for goral and serow. This could not be done at Murlen National Park due to the short time spent there. Forest Department officials were interviewed and houses in the villages surrounding the surveyed areas were visited in order to collect information on hunting. We enumerated rupicaprine trophies in the villages and measured their horn lengths.

RESULTS

Dampa Tiger Reserve: Neither goral nor serow were seen in Dampa. However, during a 2.5 km walk (Table 1) along cliffs (associated with steep slope vegetation; Fig. 1a) we found 7 dung piles of serow, 6 of which were fresh. No faecal pellets or dung piles of goral were found (Table 1). Skull trophies of hunters in Lallen, a village at the boundary of Dampa, also revealed an absence of goral skulls (Table 2).

TABLE 1

ENCOUNTER RATE OF GORAL AND SEROW PELLET GROUPS AND DUNG PILES IN THE SURVEYED PROTECTED AREAS

Protected area	Species	Pellet Groups (per km)	Dung Piles (per km)
Dampa WLS	Goral	0	0
	Serow	0	2.7 (n=7)
Murlen NP	Goral	66.0 (n=99)	10.0 (n=15)
	Serow	2.7 (n=4)	0
Phawngpui NP	Goral	51.7 (n=62)	15.0 (n=18)
	Serow	4.2 (n=5)	5.0 (n=6)

Murlen National Park: A walk along the cliffs in Murlen yielded 4 sightings of goral totalling 5 animals (3.3 goral/km; Table 3). The subspecies *N. goral hodgsoni* occurs in Mizoram. Encounter rate of goral faecal pellet groups was highest in Murlen (Table 1). We saw only 4 old faecal pellet groups of serow, and no dung piles in Murlen (Table 1). Vapar, a village at the boundary of Murlen yielded 9 goral and 41 serow skulls (Table 2).

TABLE 2

COMPARISON OF GORAL AND SEROW SKULLS COUNTED IN VILLAGES ADJOINING THE SURVEYED PROTECTED AREAS

Protected area	No. of sampled hunters' houses	Goral skulls	Serow skulls	Ratio of goral to serow skulls
Dampa WLS	2	0	8	—
Murlen NP	3	9	41	1:4.5
Phawngpui NP	2	12	39	1:3.2
Overall	7	21	88	1:4.2

Phawngpui Wildlife Sanctuary: Phawngpui had relatively large patches of steep grasslands (Fig. 1b) which could be scanned from vantage points. During such scans, we saw 10 goral, although a few of these were possibly the same animals resighted. While scanning a steep grassy slope, a maximum of 4 goral within a 200 m x 50 m area were seen. Cliff walks yielded an encounter rate of 5.8 goral/km, which was highest among all the three protected areas surveyed (Table 3). One house in Thaltlang, a village at the boundary of Phawngpui, and another in Darzo, a few kilometres away, together had 39 serow and 12 goral skulls (Table 2). Although no live serow were seen in Phawngpui, the area had the highest encounter rates for serow faecal pellet groups as well as dung piles (Table 1). All the dung piles appeared fresh.

TABLE 3

ENCOUNTER RATE OF GORAL IN THE SURVEYED PROTECTED AREAS

Protected area	Distance walked on cliffs (km)	Encounter rate of goral during cliff walks (per/km)	Total number of goral seen during cliff walks and scans
Dampa WLS	2.5	0	0
Murlen NP	1.5	3.3	4
Phawngpui NP	1.2	5.8	17

All evidences and sightings of goral and serow were restricted to steep slopes (> 30°) — serow occurring only in steep-slope vegetation and adjoining forest (Fig. 1), and goral also in the steep grasslands in Phawngpui. The only exception was a single faecal pellet group of serow (out of 9 pellet groups and 13 dung piles) in Dampa which was recorded in secondary forest vegetation approximately 200 m away from steep-slope vegetation.

The seven hunters' houses that we visited yielded 88 serow and 21 goral skulls (Table 2, 4). The average horn lengths of goral and serow were 11.6 cm and 18.8 cm respectively (Table 4).

TABLE 4

HORN LENGTHS OF GORAL AND SEROW

Species	Average Horn length (cm)		Maximum Horn length	
	Present survey	Schaller (1977)	Present survey	Schaller (1977)
Goral,	11.6 (n=14)	15.0	19.0	23.0
Serow	18.8 (n=58)	23.0	25.0	32.0

DISCUSSION

Populations of the congeneric south Asian rupicaprines, serow and goral, have declined due to unregulated hunting and habitat changes over most of their range. The Formosan serow *N. swinhoei* population, for instance, has declined due to a combination of illegal hunting and conversion of its virgin forest habitat into agricultural lands (Lue 1987). In central and eastern China, the distribution and abundance of the Chinese goral *N. caudatus* is reported to be changing rapidly (Mead 1989), while in the Amur and Ussuri region of Russia, their number is estimated to have fallen by 75% since the end of the 19th century (Zhiwotschenko 1990). In contrast, the Japanese serow *N. crispus* has benefited from strict control over hunting, and the conversion of natural forests into conifer plantations. Its population increased 25-fold between 1955 and 1979 (from 3,000 to 75,000), and the resulting damage to commercial tree plantations necessitated culling of large numbers (Horino 1990, Soma 1990, Johnsingh 1992).

In Mizoram, and much of northeast India, *jhum* is one of the major reasons for habitat change. The area under *jhum* is increasing every year. *Jhum* cycles have decreased to 3-5 years in some places, and large areas are covered by an arrested successional vegetation of weeds and bamboo (Ramakrishnan 1992). *Jhum,* however, does not seem to have affected goral substantially. Goral are grazers, graminoids forming the bulk of their diet (Green 1985, Mishra 1993, Mishra and Johnsingh 1996). They avoid areas where dense understorey vegetation hampers visibility or quick movement, and prefer steep, open grassy slopes interspersed with forest cover and cliffs (Mishra 1993, Mishra and Johnsingh 1996). Since such areas are not arable, the cliffs and steep grasslands that goral inhabit in northeast India do not undergo *jhum*. The steep grasslands in Phawngpui, for example, represent good habitat for goral (Fig. 1b). Although relatively unaffected by *jhum*, the species is unlikely to be very common over much of northeast India due to naturally restricted availability of suitable habitat. In Murlen, for instance, the habitat for goral seemed to be restricted to a chain of cliffs along the southern boundary of the Park.

In contrast to goral, no evidence of serow was recorded from the steep grasslands in Phawngpui (this habitat was almost absent in Dampa and Murlen). Serow were found using areas where primary and secondary forests bordered the steep slope vegetation along cliffs. These forested areas have relatively more tree and shrub cover and less grass cover. Phawngpui, in addition to steep grasslands, had such areas, and, in fact, both the rupicaprines were found using them - goral largely using the cliffs and serow using cliffs as well as the adjoining forest.

In spite of their steepness, *jhum* is prevalent in such forest areas. Some of the primary forest areas below the cliffs in Dampa and virtually all the areas outside the Park have been cleared for *jhum* and are covered by dense bamboo stands (Fig. 1a). The understorey vegetation in bamboo forests is considerably altered, with much lower tree and shrub species richness and abundance than primary and late-successional secondary forests (Raman 1995, Raman *et al.* in press). This habitat conversion is detrimental for serow. It is a browser, with bamboo and graminoids forming a very small proportion of its diet (Green 1985).

Hunting and relative abundance: We found people in villages around the sanctuaries well-informed of the sanctuaries and the associated restriction on hunting and *jhum*. Hunting, however, is very widespread. Birds otherwise common in human habitations are not seen in the vicinity of Mizo villages. The sight of hunters with shotguns are common on roads near forest areas and serow and goral are often victims.

It is interesting to compare the number of goral and serow skulls counted in some of the villages adjoining the surveyed areas. All areas showed a greater number of serow skulls, with an overall ratio of 4.2:1 (Table 2). Information obtained from a hunter in Murlen who had kept a record of all the animals he shot, showed a ratio of 30 serow to 3 goral. This predominance of serow skulls is largely a reflection of their greater abundance at least in the recent past. As mentioned before, this is because of greater availability of steep, dense areas in the northeast, which are used by serow, as compared to the steep, open grassy slopes used by goral. Almost all birds and mammals are hunted and eaten, suggesting that this difference in skull numbers is not due to selective hunting of serow.

Conservation efforts: The Mizoram Forest Department has taken some commendable steps toward wildlife conservation in the state. Of the total area of 21,087 km^2 of the state, about 35.3% is protected State forest. In Dampa, eleven villages were successfully shifted outside the sanctuary in 1989-90, and *jhum* is now allowed only along the village fringes. Similar efforts are being made in Phawngpui and Murlen. Thus, a basis for sound conservation strategies already exists in Mizoram. Nevertheless, pressures on land are substantial and are likely to increase in future — in 1995 the Forest Department relented to the demand of several villages to *jhum* within Dampa Tiger Reserve. Hunting is an even more immediate threat to wildlife in Mizoram. Conservation efforts have to address the issue of hunting, a part of the Mizo people's psyche (Rai and Johnsingh 1993). It is important to strengthen the Forest Department staff by providing equipment and communication facilities to deal with poachers. Such steps, coupled with special protection of key habitats such as cliffs and primary forests at the base of cliffs, are required to conserve populations of the two rupicaprines in Mizoram.

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DIVERSITY IN THE FUNCTIONAL ORGANISATION OF THE MANDIBULAR STYLETS OF ASSASSIN BUGS (HETEROPTERA: REDUVIIDAE)[1]

(*With eight Plates*)

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Key words: Assassin bugs, non-tibiaroliate, tibiaroliate, Reduviidae, mandibular stylets, mandibular lever, evolution.

Nine years of intensive survey of assassin bugs in southern India yielded 171 species belonging to 65 genera and 11 subfamilies. Diversities in the functional organisation of the mandibular stylets of 77 species of Reduviidae, representing 45 genera and 11 subfamilies of non-tibiaroliate and tibiaroliate groups of Reduviidae viz., Harpactorinae, Stenopodainae, Emesinae, Saicinae, Holoptilinae, Tribelocephalinae, Acanthaspidinae, Salyavatinae, Ectrichodiinae, Piratinae and Triatominae, collected from all the four major ecosystems (Tropical Rain Forest, Scrub Jungles, Semi-arid zones and Agroecosystem) have been critically assessed. The mandibular stylets of all Reduviidae are isomorphous, with the exception of Holoptilinae. The spatulate mandibular stylets of the myriophagous Ectrichodiinae appear to be specialised for sawing apart the septa between the segments of their prey. Depending on the feeding strategy and nutritional ethology, the organisation of the denticles present at the tip of the mandibles varies considerably. This is considered here as the main criterion for the assessment of their evolutionary significance in the various species of Reduviidae occupying diverse ecosystems. Careful observation of the shape of the mandibular lever and its significance in the evolution of the functional organisation of the stylets has been recorded.

INTRODUCTION

In Reduviids, the stylet fascicle is composed of a pair of outer mandibular stylets and a pair of inner maxillary stylets, all four of them being collectively involved in piercing and sucking operations. While the mandibular stylets are primarily responsible for piercing and anchoring, the maxillary stylets are responsible for the ejection of the saliva into the substrate through the dorsal salivary orifice and ingestion of semidigested fluid through the ventral food orifice.

The mandibular stylets, representing the incisor of the mandibles of a generalised insect, on either side of the maxillary stylets, embrace the latter and function in a groove and ridge sliding principle. Each mandibular stylet, at its base inside the head capsule, is connected to the mandibular plate of the head capsule by a highly sclerotized triangular plate called the mandibular lever. The detailed morphology of the mandibular stylets and their lever in several families of Heteroptera are known from the works of Parsons (1959, 1962, 1968 and 1969), Livingstone (1968 and 1969) and Cobben (1978).

Depending on the feeding strategy, the organisation of the denticles at the tip of the mandibles varies considerably and that is considered here as the main criterion for assessing their evolutionary significance in the various species of the Reduviidae, occupying diverse ecosystems.

In the present study, mandibular stylets of 77 species, representing 45 genera and 11 subfamilies of both non-tibiaroliate and tibiaroliate groups of Reduviidae from different

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ecosystems of southern India have been critically assessed.

MATERIALS AND METHODS

Materials were obtained from dried and preserved Reduvid specimens. The heads were boiled in 5% potassium hydroxide solution for upto 10 minutes, depending on the intensity of pigmentation, washed in weak acetic acid and again washed thoroughly in water and stored in glycerine for better clarity. The dissected materials were cleared in clove oil and mounted in polyvinyl lactophenol. Photomicrographs under light microscope were taken with Asahi Pentax photomicrographic equipment.

OBSERVATIONS

I. Non-tibiaroliate group of Reduviidae

The mandibular stylets in 42 species belonging to 26 genera and 6 subfamilies of non-tibiaroliate reduviids examined show complete isomorphism in all the subfamilies, except in the Holoptilinae in which they are dimorphic and asymmetrical. Each subfamily has certain common characters for all the genera and species, with regard to the number and disposition of longitudinal striations and arrangement of transverse denticulate serrations.

Apically, the mandibular stylets are acutely drawn out in the form of a spike and the nature and development of their denticulate serrations vary considerably. In the Harpactorinae, three longitudinal rows of such serrations are found, in which the outer rows, as in *Rhinocoris kumarii*, all *Coranus* species, both species of *Irantha* and *Polididus armatissimus* (Pl. 1, figs. 4; Pl. 2, figs. 14, 16, 17, 20, 21 & 22), are provided with three sharp, backwardly directed denticles which are not connected by transverse ridges. In the case of *Rhinocoris marginatus, R. longifrons, R. fuscipes, Euagoras plagiatus, Endochus cingalensis, E. inornatus,* both species of *Sycanus, Platerus bhavanii, Neohaematrorrhophus therasii* and *Macracanthopsis nigripes* (Pl. 1, figs. 1, 2, 3, 6, 7, 8, 9, 10; Pl. 2, figs. 13, 18 & 19) all the three rows are not interconnected by transverse serrations. In the case of *Polididus armatissimus* (Pl, 2, fig. 22) however, the two outer rows are distinctly connected by a transverse ridge without a median longitudinal row of denticulate serrations. In *Lanca kandyensis* (Pl. 2, fig. 12) these serrations are more prominently developed upto the apex, whereas in other species the more apical ones are not prominent.

In *Lophocephala guerini* (Pl. 1, fig. 5) the stylets are more membraneous except at the edges that carry prominent denticulate serrations more apically drawn into sharply pointed spikes. The stylets of all *Coranus* species are relatively narrow. In both *Rhaphidosoma* species (Pl. 3, figs. 25 & 26) the mandibular structures are entirely different from the other harpactorine species, and are more like those of the Stenopodainae in having about five to six longitudinal rows, with acutely pointed denticles at the apex. The outer rows are very sharply developed, pointing backwards. In both species of *Cydnocoris* (Pl. 2, fig. 23; Pl. 3, fig. 24) the mandibles have completely deviated from the harpactorine type, being spatulate, apically bearing three obscure rows of denticulate serrations, not connected to each other by transverse ridges.

In the Stenopodainae species like *Oncocephalus chamundaii, O. impudicus, O. klugi, O. cingalensis, O. annulipes* and *O. schioedtei* (Pl. 4, figs. 39, 40, 41, 43, 44 & 45), the mandibular stylets are uniformly similar in the arrangement of their denticulate processes. More basally, there are about 10 longitudinal rows of denticles and the number gradually diminishes apically from 4 to 1. It appears that the denticulate processes abruptly end at the posterior border of the serrated area, behind which the serrations gradually vanish. In *Canthesancus picticollis* (Pl. 4, fig. 46) the denticulate processes are much more prominently developed and many more transverse ridges are found.

In the case of *Bardesanes sericenotatus, Diaditus errabundus, Pygolampis foeda, Staccia diluta, Caunus farinator* and *Oncocephalus notatus,* (Pl. 3, figs. 33, 34, 35, 36; Pl. 4, figs. 37 & 38), the longitudinal rows are less in number, but the denticles are more powerfully developed.

In Emesinae, the mandibular stylets are acutely pointed apically. In *Stenolaemus susainathani* and *Ischnobaenella naraikkadu* (Pl. 4, figs. 47 & 48), the denticulate processes are obscure and developed in the form of more transverse ridges. About 18 to 24 such ridges are found.

The mandibular stylets of Saicinae (*Polytoxus maculatus*) (Pl. 3, fig. 31) are similar to those of Emesinae in shape, having similar rows of ridges.

The mandibular stylets of Holoptilinae (Pl. 3, figs. 27 & 28) differ from all other species in being dimorphic. Both stylets are spatulate. The right one differs from the left one in being boat-shaped with longitudinal striations. Apically, it is acutely pointed, its surface forming a keel.

In Tribelocephalinae (*Tribelocephala indica*) (Pl. 3, fig. 30) interestingly, the mandibular stylets do not have any serration but they are boat-shaped and apically pointed.

The mandibular lever in non-tibiaroliate reduviids is consistently present in all species examined and it is roughly triangular with minor variations in shape and size. While in Harpactorinae (*Sycanus collaris* and *Coranus atricapillus*) (Pl. 1, fig. 11; Pl. 2, fig. 15), Holoptilinae (*Holoptilus melanospilus*) (Pl. 3, fig. 29) and Saicinae (*polytoxus maculatus*) (Pl. 3, fig. 32), one side of the lever is more elongated. In the case of Stenopodainae (*Oncocephalus klugi*) (Pl. 4, fig. 42) the three sides are almost of the same length. The size of the lever appears to vary according to the size of the insect.

From the foregoing account it appears that among the Harpactorinae, the *Rhinocoris, Irantha, Euagoras, Macracanthopsis, Neohaematorrhophus, Platerus, Sycanus, Endochus, Lanca* and *Coranus* have a more or less similar arrangement and development pattern of denticulate serrations. In all these genera all the three rows are not transversely connected and there is gradation in the development of denticulate processes of these serrations.

Lophocephala guerini, Rhaphidosoma atkinsoni, R. tuberculatum and the two species of *Cydnocoris* are markedly different from all other species of Harpactorinae examined. In Stenopodainae, all the species of *Oncocephalus* are virtually similar in their identity. The mandibular stylets of *Staccia, Oncocephalus notatus, Diaditus, Pygolampis* and *Caunus* have closer affinity with one another. *Canthesancus* and *Bardesanes* are also similar. The similarity of the mandibular stylets of the Emesinae and Saicinae (*Polytoxus*) is very significant.

Mandibular stylets of the Tribelocephalinae, by their boat-shaped structure, appear to be unique among Reduviidae and the characteristic asymmetry of the mandibular stylets of Holoptilinae could be also considered as a unique feature among Reduviidae.

II. Tibiaroliate group of Reduviidae

Studies on 35 species representing 19 genera and 5 subfamilies of the tibiaroliate group of Reduviidae of southern India confirmed that both mandibular stylets in all these species are perfectly symmetrical and isomorphic. The denticles of the serration, however, vary in their number and extent of development.

In Acanthaspidinae, all species examined have three longitudinal rows of serrations, but the development of the denticles in the transverse rows varies considerably. The more slender and acutely pointed the mandible is, the more sharply defined are the denticles of the transverse rows, as in *Acanthaspis siva, A. quinquespinosa, A. angularis, A. rugulosa* and *A. lineatipes* (Pl. 6, figs. 63, 64, 65, 66 & 68). In *Reduvius delicatula* (Pl. 7, fig. 75) the mandibular stylets are more sharply defined than in other species in which mandibles are not very acutely pointed apically and their denticles are not so sharply defined, as in *Acanthaspis pedestris* and *A. siruvanii* (Pl. 6, figs. 62 & 67). In *Apechtia mesopyrrha, Pasira perpusilla* and *Neoacanthaspis maculatus* (Pl. 6, figs. 70, 71; Pl. 7, fig. 77) the stylets are broad and bluntly pointed and their apical transverse denticles just moderately developed. In *Apechtia mesopyrrha* and *Pasira perpusilla* they are significantly poor in their formation. However, in these two species the stylets carry certain minute backwardly directed serrations, far behind the apex and they are better pronounced in *Pasira perpusilla* (Pl. 6, fig. 72). In *Edocla slateri* and *Edocla maculatus* (Pl. 7, figs. 73 & 74) the mandibular stylets are similar in the development of their denticles along with the three longitudinal rows. In *Platymeris laevicollis* (Pl. 7, fig. 76) also, the serrations are arranged in three longitudinal rows.

In Salyavatinae, the denticles are arranged in three rows but unlike Acanthaspidinae, the three rows are not transversely connected. However, a slight indication of the same is seen in *Nudiscutella frontispina* (Pl. 5, fig. 59) and *Lisarda annulosa.* (Pl. 5, fig. 58). The posterior edge of the stylets, far behind the apical rows of the denticles, is sharply serrated. These serrations are directed forward in *Petalochirus brachialis* (Pl. 5, fig. 60). In *N. frontispina* such serrations are ill-defined. The denticles in all the three rows are equally well formed, and better defined than those of Acanthaspidinae.

In Ectrichodiinae all the four species of *Ectrychotes,* namely, *E. dispar, E. pilicornis, E. bharathii* and *E. atripennis* (Pl. 5, figs. 49, 50, 51 & 52), have mandibular stylets almost abruptly expanding beyond the middle, whereas in *Labidocoris elegans, Haematorrhophus nigroviolaceous* and *Stegius pravus* (Pl. 5, figs. 53, 54, 55 & 56) such expansion is gradual. Such a mandibular stylet in Ectrichodiinae is unique in being spatulate without any trace of denticulate serrations, unlike all other species of tibiaroliate group of Reduviidae.

In Piratinae, each of the four genera examined show significant variation. In general, most of the *Ectomocoris* species, namely *E. tibialis, E. tuberculatum, E. quadriguttatus* and *E. cordiger* (Pl. 7, figs. 80, 81, 82 & 83), have six longitudinal rows of serrations at the base of the denticulate areas of the stylet, of which the denticles of the outermost rows are more sharply defined. There are about eleven such denticles on the two peripheral longitudinal rows. In *Catamiarus brevipennis* and *Sirthenea flavipes* (Pl. 8, figs. 90 & 91) as well as in all other *Pirates* species, there are about four distinct longitudinal rows of serrations. In *C. brevipennis* (Pl. 8, fig. 90) they are better defined than in the others. While all the four species of *Pirates* namely *P. affinis, P. quadrinotatus, P. lepturoides* and *P. atromaculatus* and in *C. brevipennis* (Pl. 8, figs. 85, 86, 87, 88 & 90), the more apical denticles are flattened and less conspicuous. In *Sirthenea flavipes* (Pl. 8, fig. 91) the more apical ones are highly conspicuous and sharply developed.

In Triatominae, the stylet tip is sharply pointed, there is only one series of sharply defined denticles and about eight such prominent denticles could be recognised. Among all the tibiaroliate reduviids examined, *Triatoma rubrofasciata* (Pl. 7, figs. 78 & 79) has the maximum development of mandibular stylet. It is the only haematophagous reduviid examined.

Thus, among all the 36 species of tibiaroliate reduviids examined, *Triatoma rubrofasciata* has the most specialised mandibular stylets and *Pirates* sp. have the least developed stylets. Acutely pointed mandibular stylets are met with in the alate group of Acanthaspidinae. It is observed that *Ectomocoris* has more specialised mandibular stylets compared with other genera of Piratinae and the genus *Acanthaspis* is considered to be most specialised when compared with all other genera of Acanthaspidinae. Interestingly, the alate species of *Acanthaspis* have better developed mandibular denticles than their apterous counterparts. Members of the subfamily Ectrichodiinae have attained a unique type of specialization for myriophagy.

The mandibular lever, as revealed in a number of species of tibiaroliate reduviids in the present investigation, is roughly triangular with perceptible variation in its size. The lever of Acanthaspidinae (*Acanthaspis pedestris*) (Pl. 6, fig. 69), Piratinae (*Ectomocoris cordiger* and *Pirates atromaculates*) (Pl. 7, fig. 84; Pl. 8, fig. 89) Ectrichodiinae (*Haematorrhophus nigroviolaceus* (Pl. 5, fig. 57) is more or less similar, but for minor variations in the development of their angles. The lever of Salyavatinae (*Lisarda annulosa*) (Pl. 6, fig. 61) is different from all others in being very tiny and T-shaped. It is larger in Ectrichodiinae.

Discussion

The structure of the mandibular stylets of Reduviidae manifests a wide range of variations and provides sufficient evidence to trace the course of evolution of carnivory in these insects. In the phylogenetic relationship within subfamilies, however difficult it may be to establish, each subfamily presents a wide range of parallel evolution in stylet structures.

The fact that Holoptilinae alone, among all other Heteroptera, present dimorphism in mandibular stylets, as reported by Cobben (1978) and confirmed by the present investigation, suggests that Holoptilinae could be regarded as an early offshoot from the Reduviid stem. Emesinae and Saicinae closely resemble each other in having more conspicuously tapered needle-like mandibles. This tendency to taper is indicated in the mandibular stylets of the Stenopodainae as well. In *Lophocephala guerini* (Phonolibinae) as well as in Rhaphidosominae, the mandibles are more acutely pointed since both of them have termites as their staple prey, and probing for termites underneath dried faecal material (Livingstone and Ambrose 1984) is mainly achieved by the mandibular stylets.

A comparison of mandibular stylets of species of the three major categories of carnivory in Reduviidae, namely myriophagy, haematophagy and entomophagy, represented by Ectrichodiinae, Triatominae and the rest respectively, provides valuable information on the nutritional strategies of these bugs in their respective ecosystems in particular, and their evolutionary significance in general. The development of a single series of highly denticulate serrations on an extremely slender mandibular stylet of Triatominae could be interpreted as an efficient piercing mechanism, over a highly sensitive host skin. According to Lavoispierre *et al.* (1959), in *Triatoma,* entry of the stylets into the host skin is very rapid, initiated by alternating movements of the mandibular stylets which, after having penetrated into the tissue of the host, remain still and the maxillary stylets project far beyond the mandibles, as a single bundle.

The blade-like, sharp edges of the spatulate type of mandibles of Ectrichodiinae can easily saw the septa between the segments of millipedes, once the stylet fascicle has established entry through the intersegmental membrane. A spatulate mandibular stylet has the advantage of advancing deeper inside the host's body rather than anchoring alone. According to Cobben (1978), it might be the beginning of evolution of a functional relationship in which the mandibles control deviation of the maxillary bundle. A close relationship with the mandibles of myriophagous species of Ectrichodiinae is recognized only in both species of *Cydnocoris* that exhibit a sharp deviation from the normal condition of mandibular stylets in all other entomophagous species. However, both species of *Cydnocoris* have been found to feed freely on houseflies in the laboratory.

Harpactorinae, in general, have their mandibular stylets neither acutely pointed as in

Emesinae nor spatulate as in Ectrichodiinae, though Cobben (1978) has described the mandibles of both Harpactorinae and Ectrichodiinae as spatulate. In Tribelocephalinae, which feed mainly on termites, the mandibular stylets appear to be intermediate between Emesinae and Harpactorinae. Most species of Harpactorinae are polyphagous, whereas ant-feeding Holoptilinae and termite-feeding Phonolibinae (*Lophocephala*), Rhaphidosominae and Tribelocephalinae tend to be monophagous. Hence it was easy to rear Harpactorine species on different hosts and it is difficult to rear all other species that feed exclusively on termites.

The development of serrations with denticulate processes, at the tip of mandibular stylets appears to be common in all the species except *Tribelocephala* in which they are obscure and rarely found, and it is apparently difficult to attribute predatory efficiency based on the manner of development of such serrations in the mandibular stylets of Reduviidae. However, it is evident that the shape of the mandibular stylets and their armature in most cases are directly related to the nature of predation of their natural prey. The evolution of mandibular stylets, therefore, could be correlated with the prey and feeding strategies.

In the entomophagous group, the development of a greater number of rows of denticulate serrations was considered as a more efficient predatory device, amply illustrated by *Ectomocoris,* that could be considered as one with a more efficient mechanism of predation. Cobben (1978) is of the opinion that the mandibles became increasingly flattened and extensively sculptured with the evolution of phytophagy from carnivory. The mandibles in phytophagous species serve initially as a piercing device, and once penetration is achieved they serve as an anchoring device. Since the tibiarolium of *Ectomocoris* has reached the maximum development among the tibiaroliate group of Reduviidae (Livingstone and Ambrose, 1984) the mandibular armature may be considered as an additional attribute towards efficiency in predation. However, reduction of armature of any form in an appendage, especially the stylets, is an apomorphic feature and for that reason the multiplicity of denticulate serrations in *Ectomocoris* could be regarded as a plesiomorphic feature among the tibiaroliate Reduviidae. According to Cobben (1978), a larger mandibular lever is correlated with the curved base of the stylet, allowing greater force and striking velocity during harpooning of the prey. It allows torsion of the mandibular stylet by the action of the sets of muscles. A quadrangular mandibular lever, commonly reported in *Gerromorpha* (Ekblom, 1926 & 1930; Elson, 1937; Spooner, 1938; Servadei, 1946; Parsons, 1962 and Cobben, 1978) has been considered as an autogenic transformation from a normal triangular lever in the nymphal instars, and according to Cobben (1978) such a type is the IVth type of lever that provides the mandibular stylet with greater rapidity and force in harpooning. A triangular type is the type II of Ekblom (1926) and in the present study the lever could be rated as an intermediate one between type II and type IV. The larger size of the triangular lever in Ectrichodiinae could be correlated with the unusual spatulate shape of the stylet that aids in sawing the intersegmental septa of the myriapod prey. Therefore, it is suggested that myriapod feeding is a remarkable line of specialization achieved by the Ectrichodiinae alone.

According to Cobben (1978), the mandibles become increasingly flattened and extensively sculptured with the evolution of phytophagy from carnivory and the increased capacity to protrude the mandibles arose independently in Reduviidae, Nabidae and Anthocoridae. It is suggested that the mandibular stylets initially serve as the anchoring device, enabling the maxillary stylets to perform exploratory movements inside the host tissue, preparatory to feeding.

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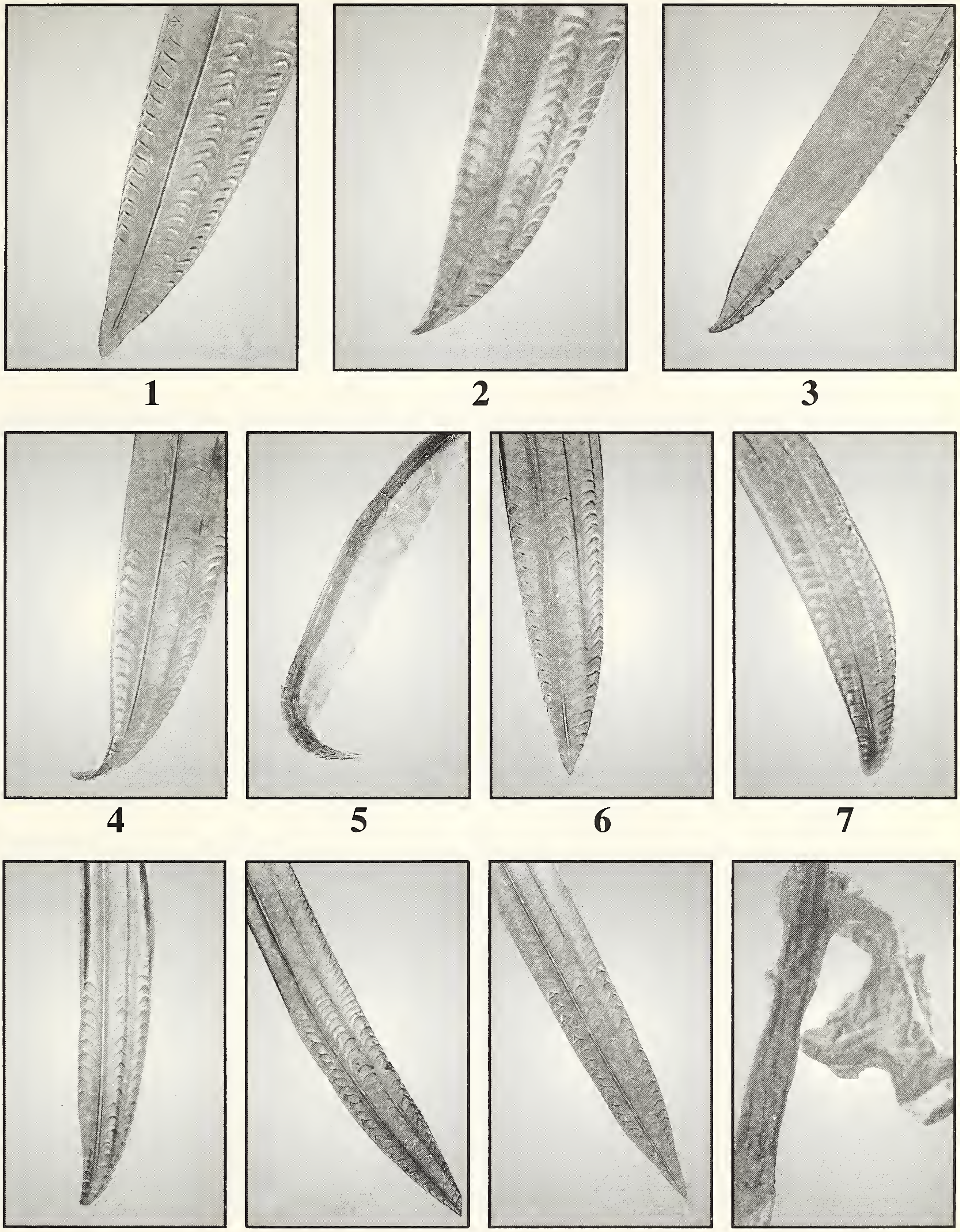
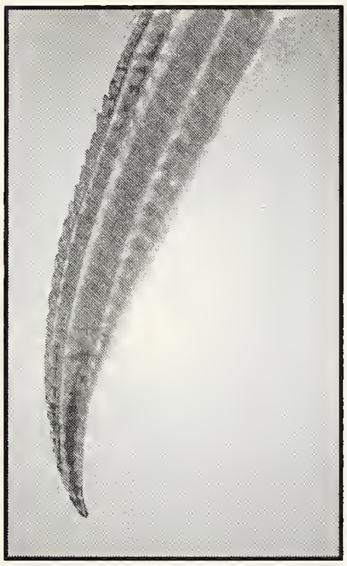


Figs. 1-11: 1. *Rhinocoris marginatus* Laporte (200 x); 2. *Rhinocoris longifrons* Stal (400 x); 3. *Rhinocoris fuscipes* Fabricius (400 x); 4. *Rhinocoris kumarii* Ambrose & Livingstone (400 x); 5. *Lophocephala querini* Laporte (400 x); 6. *Euagoras plagiatus* Burmeister (400 x); 7. *Endochus cingalensis* Stäl (400 x); 8. *Endochus inornatus* Stäl (400 x); 9. *Sycanus pyrrhomelas* Walker (200 x); 10. *Sycanus collaris* Fabricius (200 x); 11. *Sycanus collaris* Fabricius (mandibular lever) (200 x).



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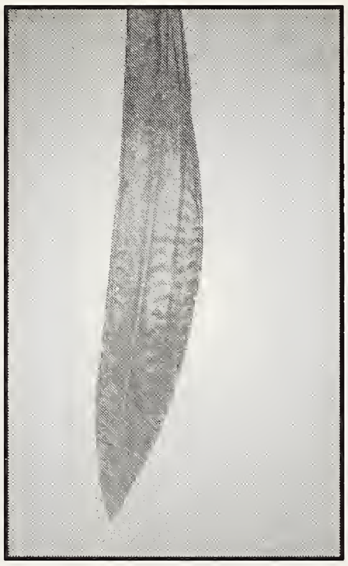

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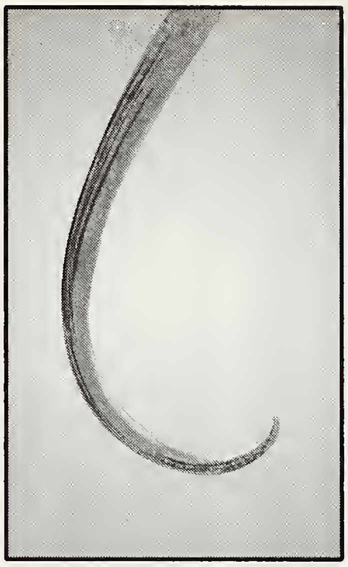

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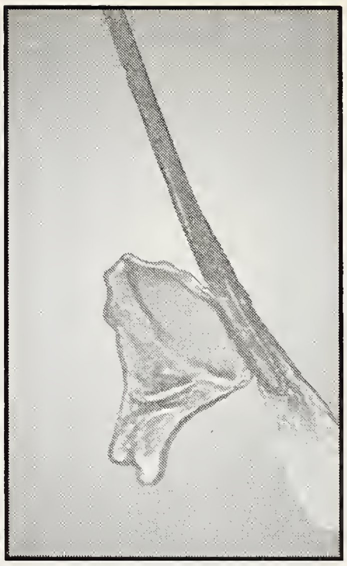

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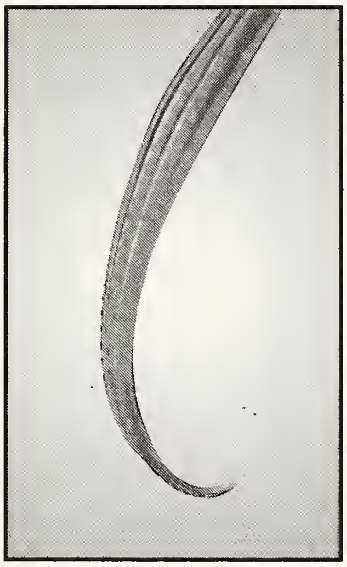

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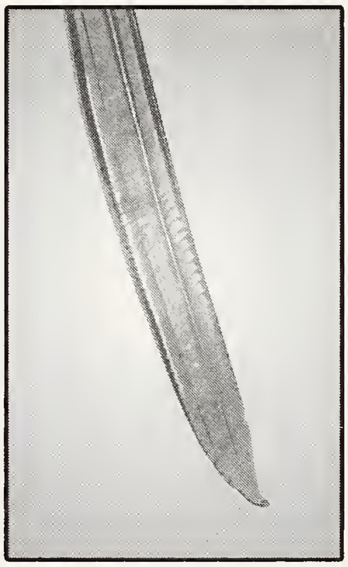

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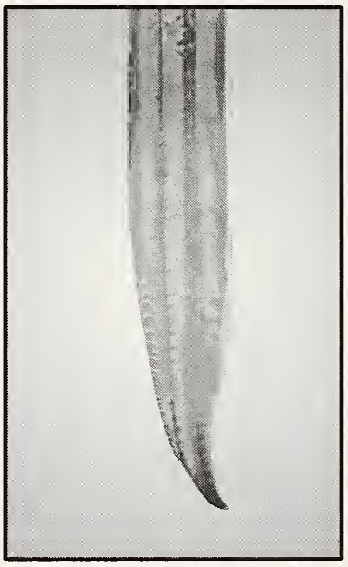

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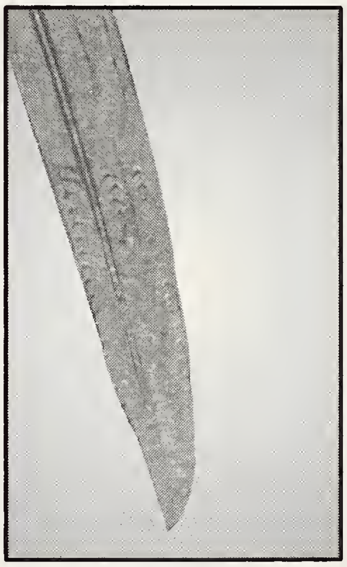

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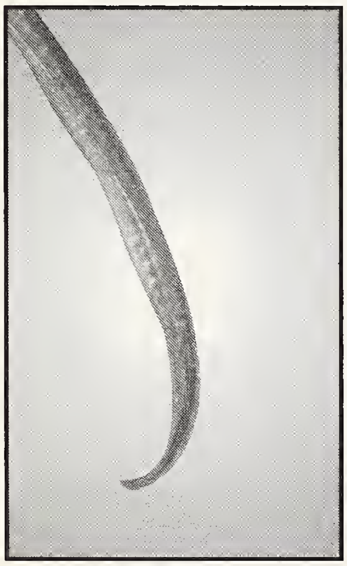

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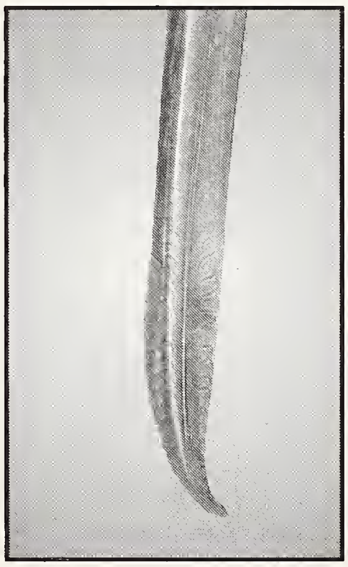

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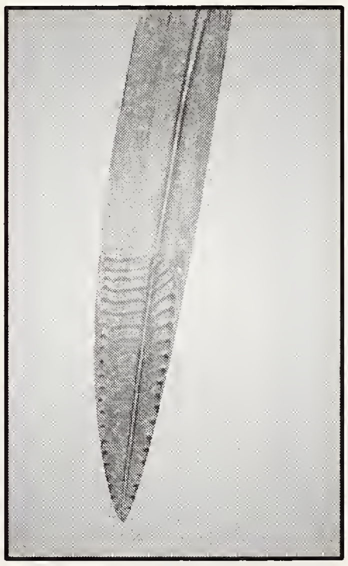

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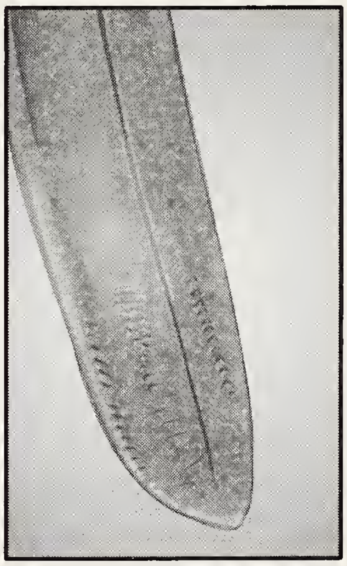

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Figs. 12-23: 12. *Lanca kandyensis* Distant (400 x); 13. *Platerus bhavanii* Livingstone & Ravichandran (400 x); 14. *Coranus atricapillus* Distant (400 x); 15. *Coranus atricapillus,* Distant (mandibular lever) (200 x); 16. *Coranus vitellinus* Distant (400 x); 17. *Coranus spiniscutis* Reuter (400 x); 18. *Neohaematorrhophus therasii* Ambrose & Livingstone (400 x); 19. *Macracanthopsis nigripes* Distant (400 x); 20. *Irantha pepparii* Livingstone & Ravichandran (200 x); 21. *Irantha armipes* Stäl (400 x); 22. *Polididus armatissimus* Stäl (400 x); 23. *Cydnocoris gilvus* Burmeister (200 x).

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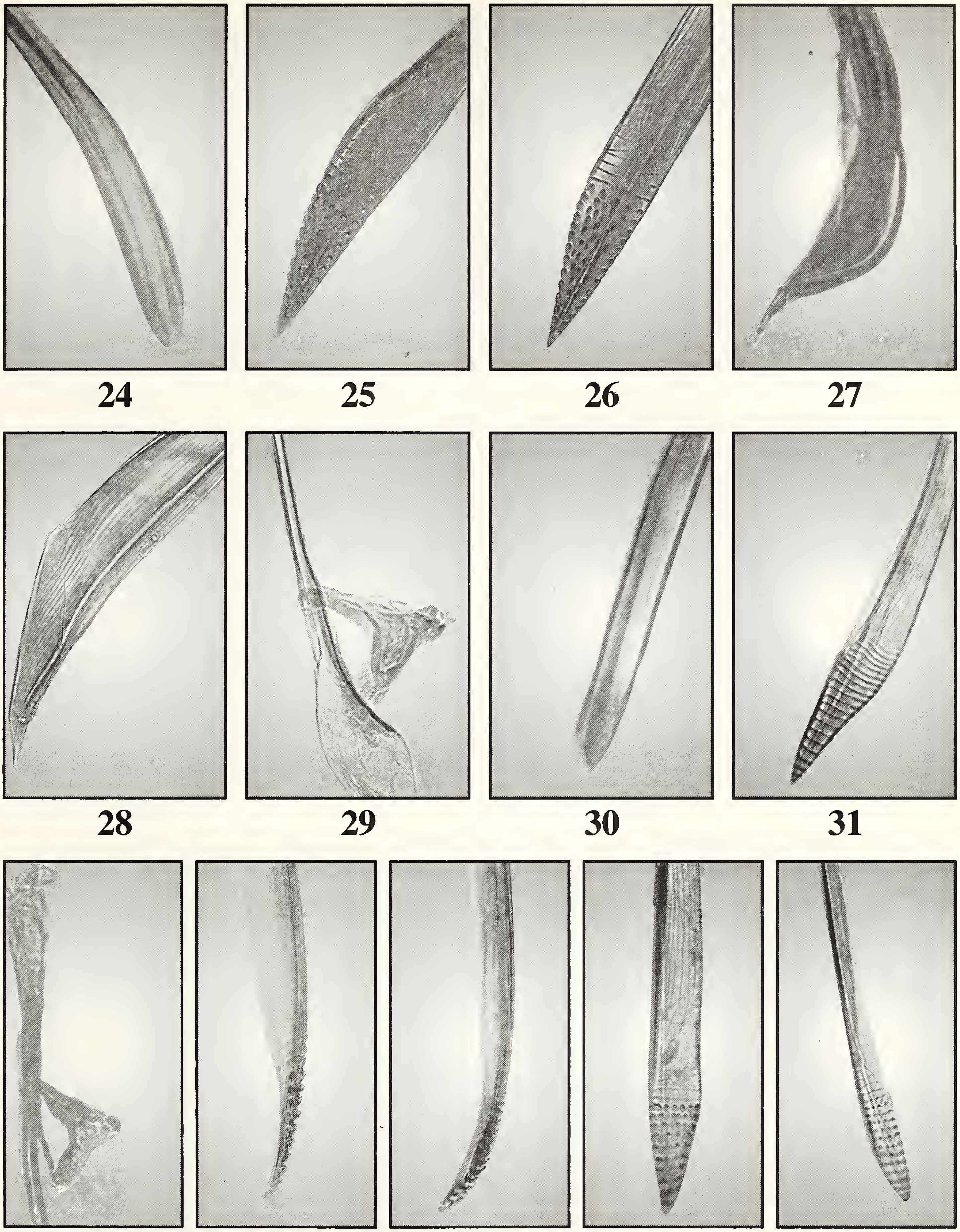

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Figs. 24-36: 24. *Cydonocoris crocatus* Stäl (100 x); 25. *Rhaphidosoma atkinsoni* Bergroth (200 x); 26. *Rhaphidosoma tuberculatum* Distant (200 x); 27. *Holoptilus melanospilus* Walker (Lt. Md. Stylet) (400 x); 28. *Holoptilus melanospilus* Walker (Rt. Md. Stylet) (400 x); 29. *Holoptilus melanospilus,* Walker (lever) (200 x); 30. *Tribelocephala indica* Walker (200 x); 31. *Polytoxus maculatus* Distant (400 x); 32. *Polytoxus maculatus* Distant (mandibular lever) (200 x); 33. *Bardesanes sericenotatus* Livingstone & Ravichandran (400 x); 34. *Diaditus errabundus* Distant (400 x); 35. *Pygolampis foeda* Stäl (400 x); 36. *Staccia diluta* Stäl (400 x).

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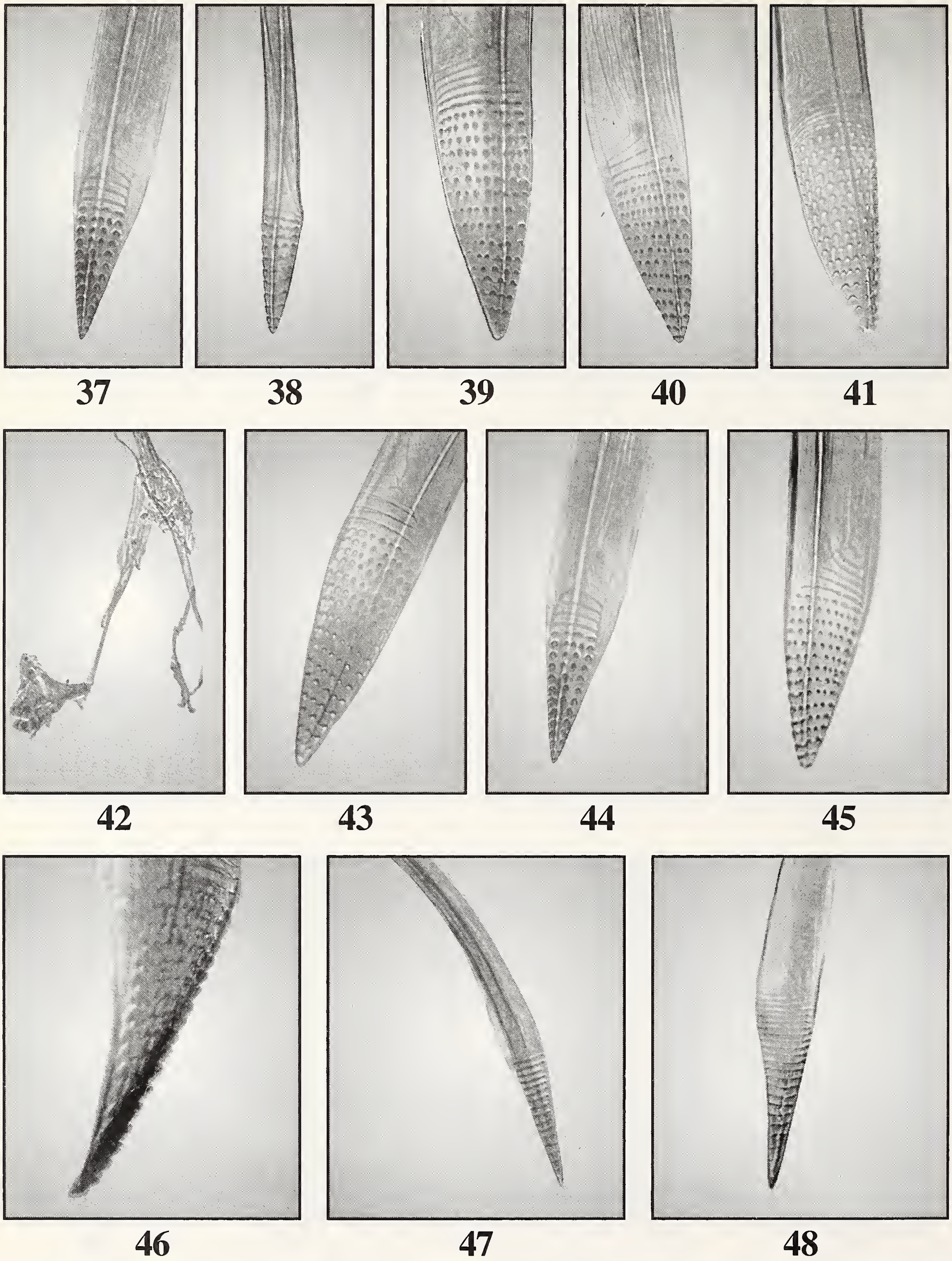
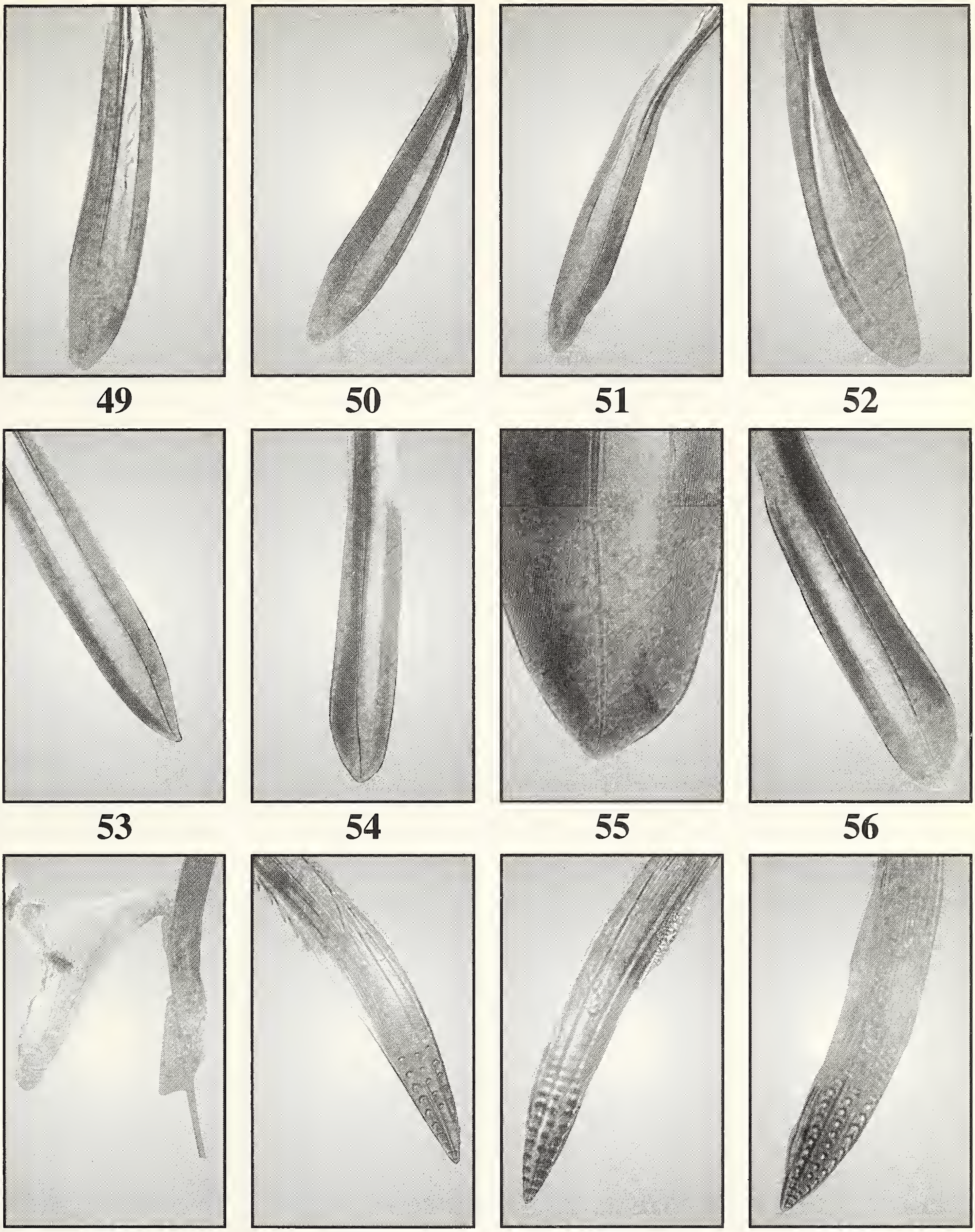
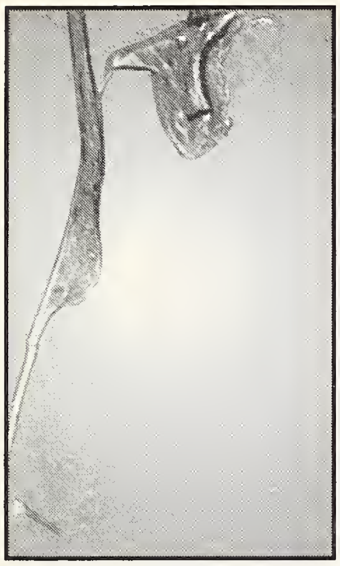


Figs. 37-48: 37. *Canus farinator* Reuter (400 x); 38. *Oncocephalus notatus* Klug (400 x); 39. *Oncocephalus chamundaii* Livingstone & Ravichandran (400 x); 40. *Oncocephalus impudicus* Reuter (400 x); 41. *Oncocephalus klugi* Distant (400 x); 42. *Oncocephalus klugi* Distant (mandibular lever) (200 x); 43. *Oncocephalus cingalensis* walker (400 x); 44. *Oncocephalus annulipes* Stäl (400 x); 45. *Oncocephalus schioedtei* Reuter (400 x); 46. *Canthesancus picticollis* Stäl (400 x); 47. *Stenolemus susainathani* Wygodzinsky (400 x); 48. *Ischnobaenella naraikkadu* Wygodzinsky (400 x).



Figs. 49-60: 49. *Ectrychotes dispar* Reuter (100 x); 50. *Ectrychotes pilicornis* Fabricius (100 x); 51. *Ectrychotes bharathii* Murugan & Livingstone (100 x); 52. *Ectrychotes atripennis* Stäl (200 x); 53. *Labidocoris elegans* Mayr (100 x); 54. *Haematorrhophus nigroviolaceus* Reuter (50 x); 55. *Haematorrhophus nigroviolaceus* (magnified view) (200 x); 56. *Stegius pravus* Distant (100 x); 57. *Haematorrhophus nigroviolaceus* Reuter (mandibular lever) (50 x); 58. *Lisarda annulosa* Stal (400 x); 59. *Nudiscutella frontispina* Murugan & Livingstone (400 x); 60. *Petalochirus brachialis* Distant (400 x).



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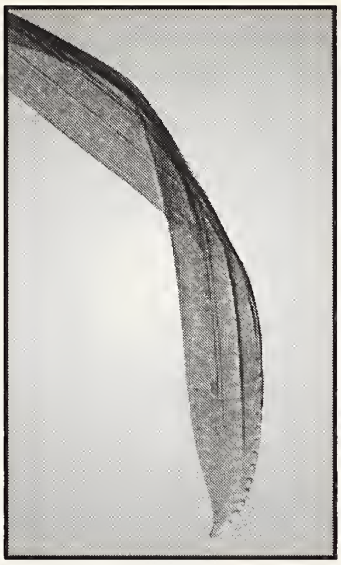

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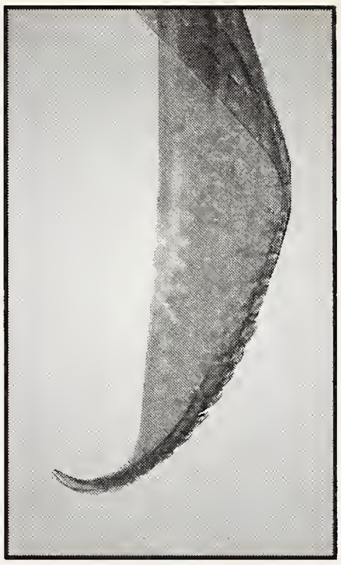

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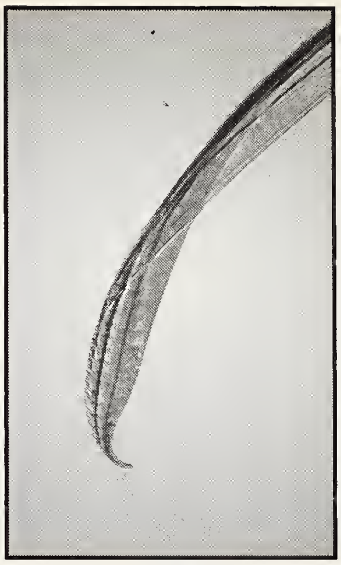

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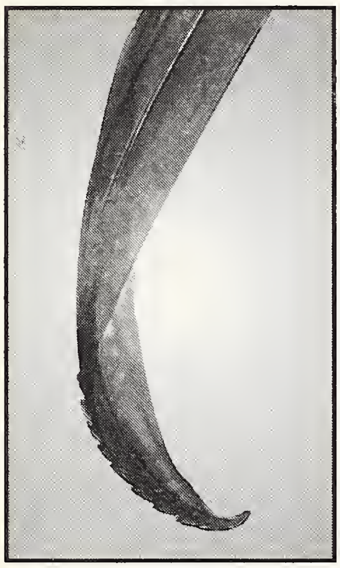

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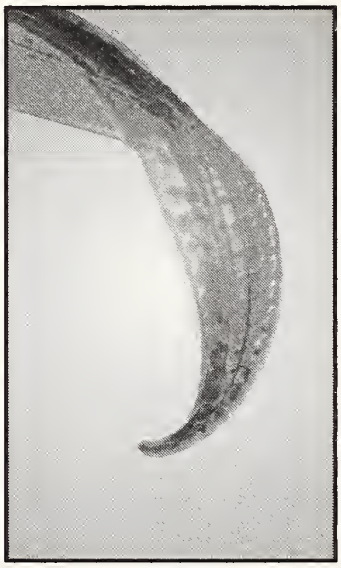

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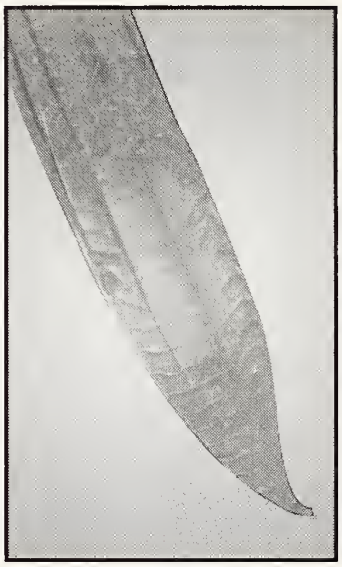

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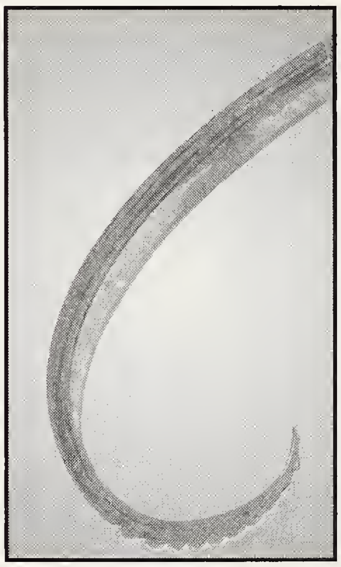

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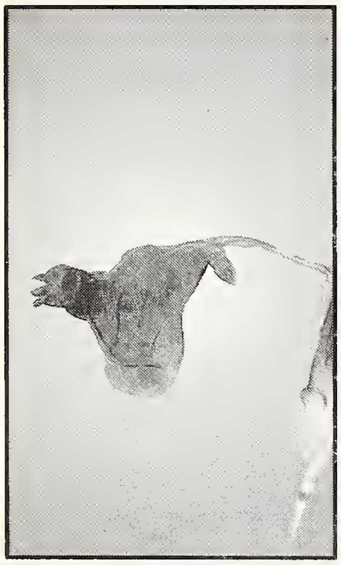

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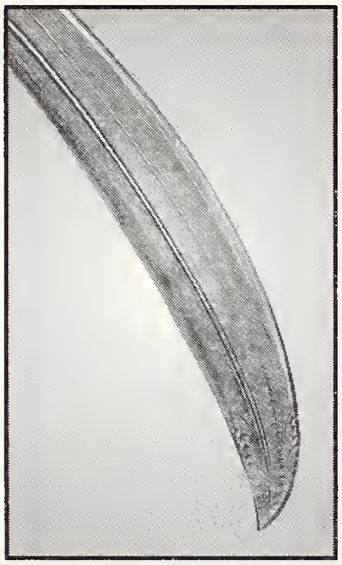

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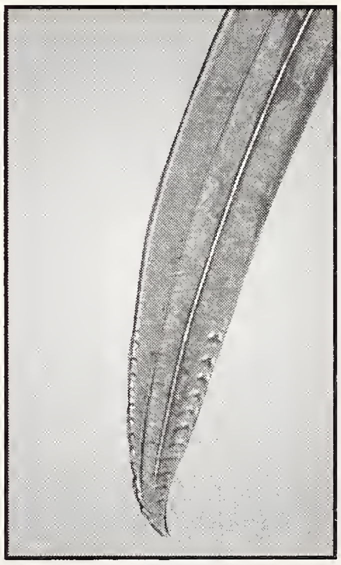

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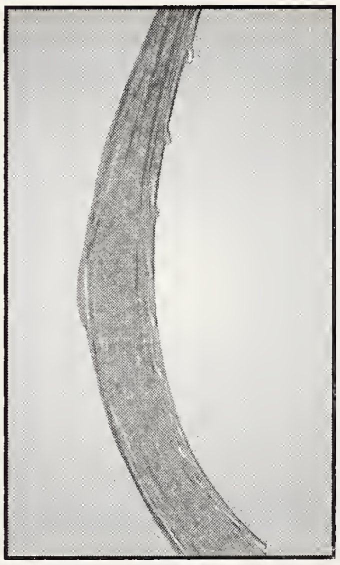

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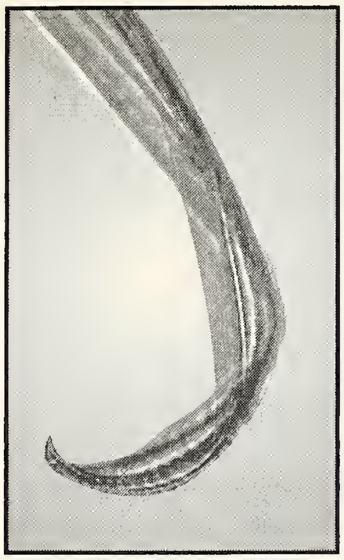
Figs. 61-72: 61. *Lisarda annulosa* Stäl (mandibular lever) (200 x); 62. *Acanthaspis pedestris* Stäl (200 x); 63. *Acanthaspis siva* Distant (400 x); 64. *Acanthaspis quinquespinosa* Fabricius (200 x); 65. *Acanthaspis angularis* Stäl (400 x); 66. *Acanthaspis rugulosa* Stäl (400 x); 67. *Acanthaspis siruvanii* Murugan & Livingstone (400 x); 68. *Acanthaspis lineatipes* Reuter (400 x); 69. *Acanthaspis pedestris* Stäl (mandibular lever) (100 x); 70. *Apechtia mesopyrrha* Reuter (200 x); 71. *Pasira perpusilla* Walker (400 x); 72. *Pasira perpusilla* Walker (mandibular lever) (400 x).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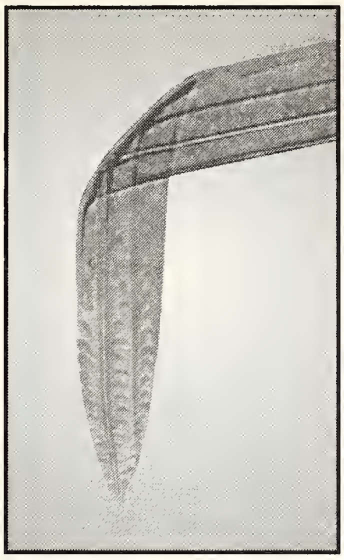
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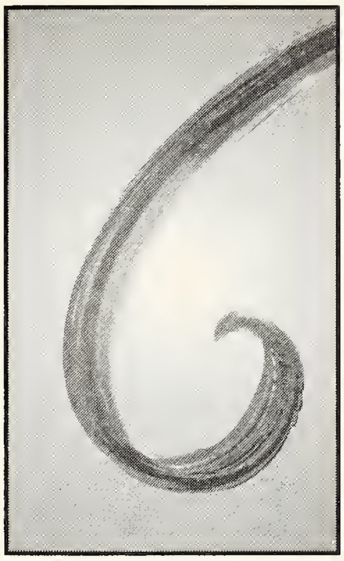
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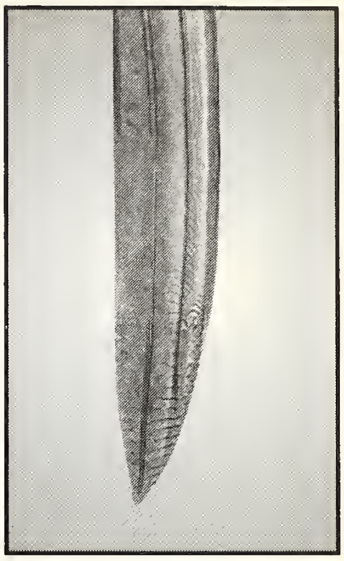
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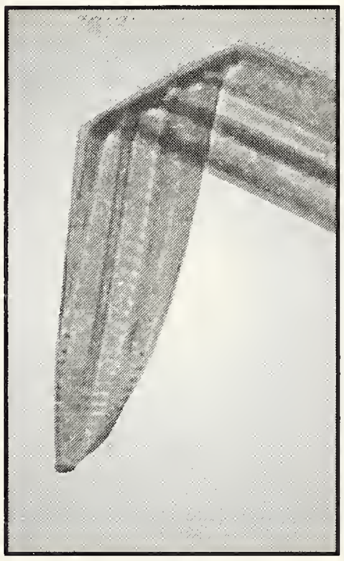
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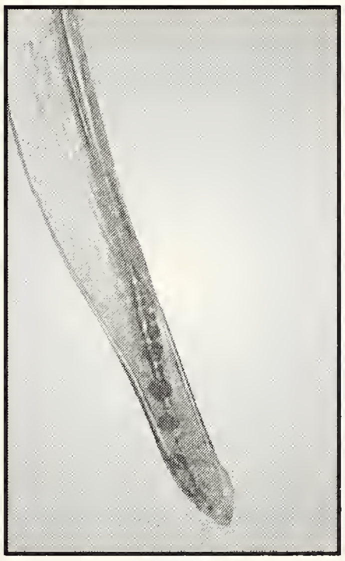
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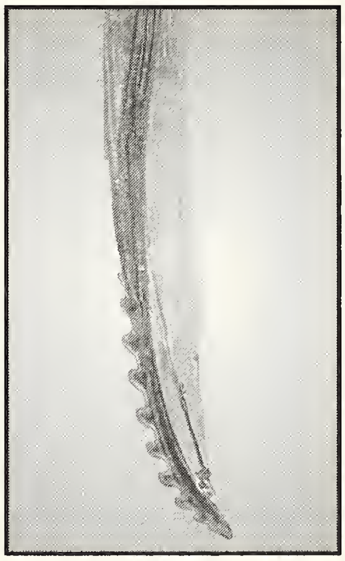
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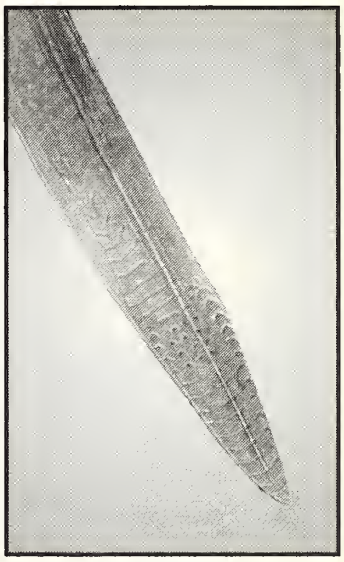
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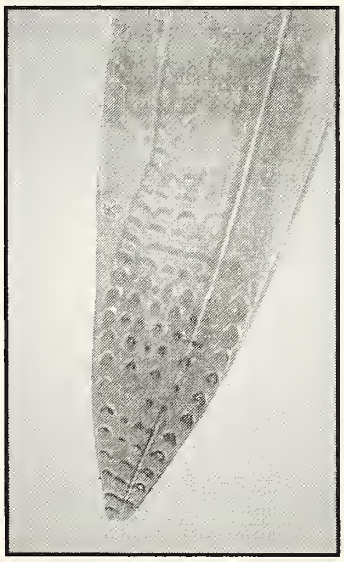
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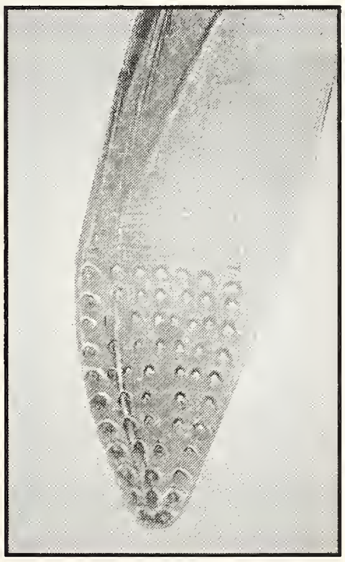
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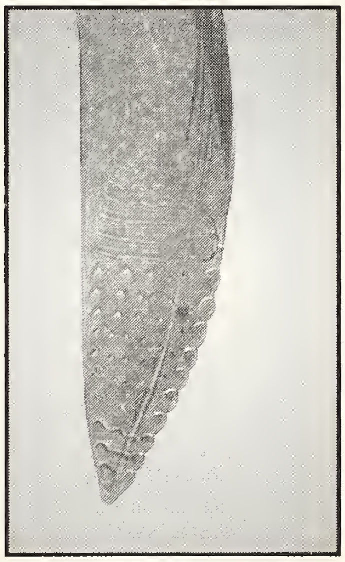
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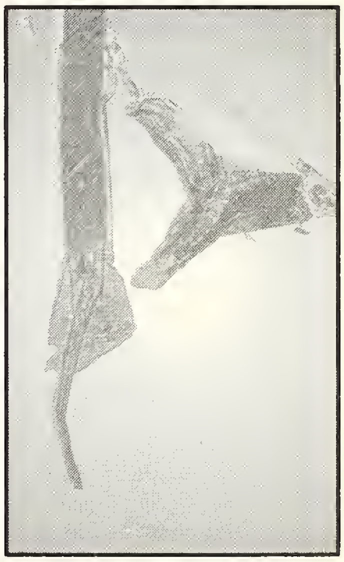
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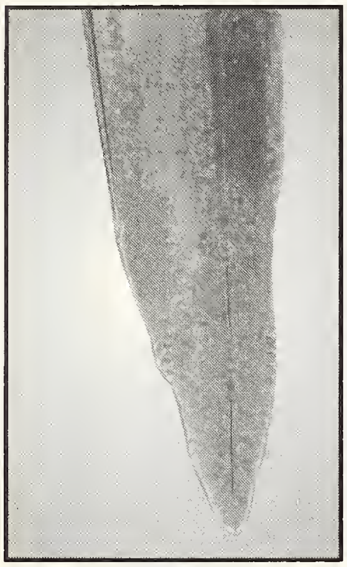
Figs. 73-84: 73. *Edocla slateri* Distant (400 x); 74. *Edocla maculatus* Murugan & Livingstone (400 x); 75. *Reduvius delicatula* Distant (400 x); 76. *Platymeris laevicollis* Distant (100 x); 77. *Neoacanthapis maculatus* Murugan & Livingstone (200 x); 78. *Triatoma rubrofasciata* de Geer (dorsal view) (400 x); 79. *Triatoma rubrofasciata* de Geer (ventral view) (400 x); 80. *Ectomocoris tibialis* Distant (400 x); 81. *Ectomocoris tuberculatum* Livingstone & Murugan (400 x); 82. *Ectomocoris quadriguttatus* Fabricius (400 x); 83. *Ectomocoris cordiger* Stäl (400 x); 84. *Ectomocoris cordiger* Stäl (mandibular lever) (100 x);



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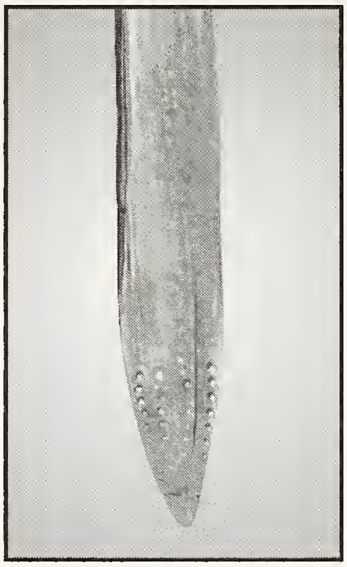

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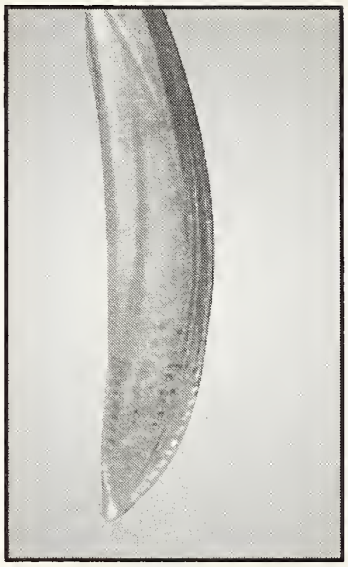

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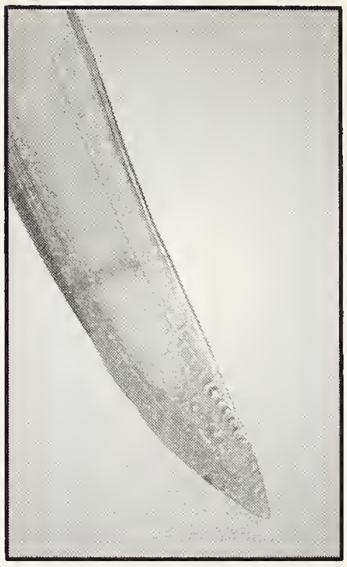

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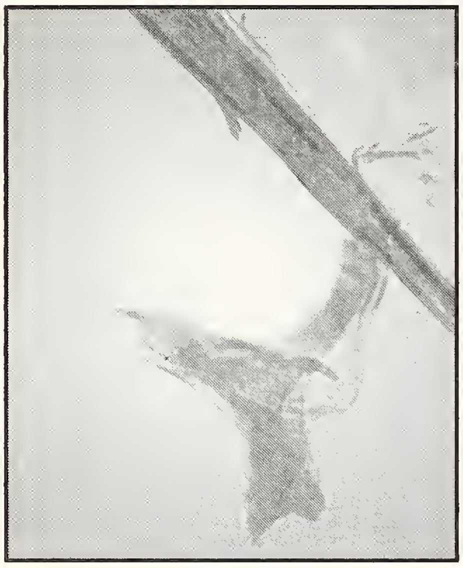

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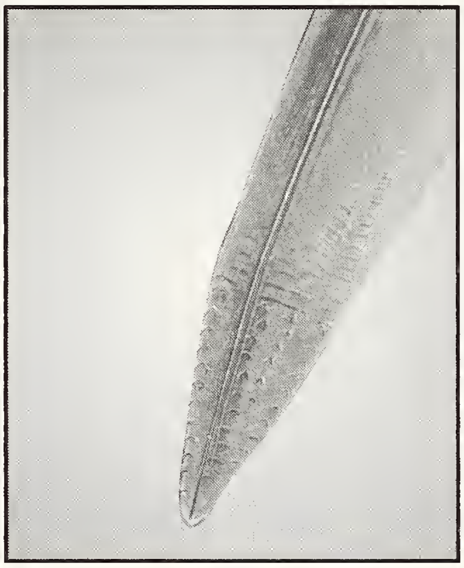

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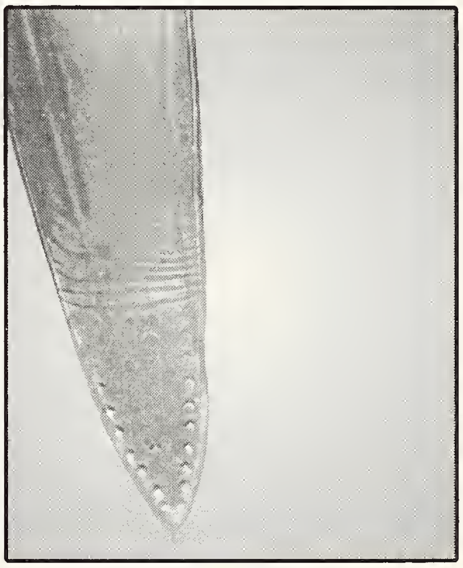

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85. *Pirates affinis* Serville (200 x); 86. *Pirates quadrinotatus* Fabricius (400 x); 87. *Pirates lepturoides* Wolff (400 x); 88. *Pirates atromaculates* Stäl (400 x); 89. *Pirates atromaculates* Stäl (mandibular lever) (200 x); 90. *Catamiarus brevipennis* Serville (200 x); 91. *Sirthenea flavipes* Stäl (400 x).

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NEW RECORD OF SIX MARINE FISHES FROM ST. MARTIN'S CORAL ISLAND, BAY OF BENGAL, IN BANGLADESH[1]

Mohammad Ali Reza Khan[2]

Key words: *Acanthus fuliginosus, Apogon endekataenia, Choreodon robustum, Halichoeres javanicus, Sargocentron rubrum, Thalassoma lunare,* St. Martin's Coral Island, Bangladesh.

This paper deals with 10 species of marine, coral-associated bony fishes from the lone coral island in the eastern part of the Bay of Bengal. Six of these are reported from the country for the first time. Their ecology and utilisation have also been discussed.

Introduction

Bangladesh is a country of rivers, rivulets, marshes, estuaries, islands and long coastal belts. Nearly 250 species of freshwater and 475 species of marine fishes, including some 50 species of cartilaginous fishes (Hussain 1970, Rahman 1989 and Khan *et al.* 1995) have been recorded in its waters. Bangladesh is heavily dependent on the supply of marine fish to feed its own population and the export industry of non-traditional items. Ichthyologists of Bangladesh started studying its fish resources in the early nineteen fifties (Ahmad 1953) when the country was known as East Pakistan. These old records of the Pakistan era and the work done during the current decade, for some reason, do not include most of the fishes that live among the corals of Bangladesh. It is apparent from the existing literature and from my own field observations that nearly 200 species of marine fish, including 12 cartilaginous species are landed in the fish market of St. Martin's Coral Island. Most of these are traditionally commercial fishes that are being used for human consumption at home or abroad and for making fish meal. Even this list does not include species such as *Acanthus fuliginosus, Apogon endekataenia, Choreodon robustum, Halichoeres javanicus, H. marginatus, Kyphosus cinerascens, Lutjanus lutjanus, Sargocentron rubrum* and *Thalassoma lunare.* The status of several other species also appears to be uncertain.

In this paper I have attempted to provide first hand information on the ecology of six species of fishes that inhabit the coral reefs of Bangladesh. However, it seems all these species have already been reported from other parts of the Bay of Bengal but Bangladesh (Chhapgar 1989, Day 1878, Misra 1959, Munro 1955).

Study Area and Methodology

Of the several hundred offshore and inshore islands in Bangladesh, one alone is apparently formed of boulders and ringed by corals (Khan 1964, Khan 1982). This is the St. Martin's Coral Island that is locally known as Narikel Jinjira. Located beyond the southeasternmost tip of Bangladesh and opposite the Myanmar coast of Akyab, St. Martin's Coral Island is tiny, 8 sq. km in expanse. It is dominated by coconut trees and lies between 20° 30' - 20° 39' N and 92° 18' - 92° 21' E. The Coral Island is formed of a large main island and three separated islets. The main island has three distinct human habitations under a village system known as Uttar Para (northern village), Maddhya Para (middle village) and Dakshin Para (southern village). The three southernmost islands are collectively known as

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Siradia (meaning separated islands), covering another square kilometre or so (Khan 1985). The latter is connected to the southeasternmost corner of the main island only during ebb tide. Coral Island is a sedimentary continental island and its main portion is dumbbell-shaped because of two saucer-like underground base rocks (Choudhury 1985).

A border river, called Naaf, runs through the international boundary of Bangladesh and Myanmar. It ends in the Bay of Bengal. At this meeting point, on one side is the last landmass of Bangladesh, the Badarmukam and Maungdu, the last corner of the Akyab coast of Myanmar. A 12 km wide channel of the Bay of Bengal separates Coral Island from both the countries.

The island has been inhabited since 1850 and at present there are about 600 families with 4000 people. Almost all the islanders are fishermen. Their fishing activities are limited from October to April, which is the period of fair weather. The remaining period of the year is usually too windy, rainy or cyclonic, so that the islanders do not dare to venture out in the Bay. All administrative, social and economic activities of the islanders are restricted to Uttar Para (Khan, 1998).

During the SW monsoon, communication with Coral Island and the nearest Bangladesh border-town of Teknaf remains disrupted for an appreciable period. Rarely do any outsiders visit the island at such a period. Some islanders practice agriculture following monsoon showers. Others remain engaged in tending the coconut gardens, making new fishing nets or repairing old ones and catching fish from nearby areas during the monsoon (Khan, 1998).

I started visiting Coral Island from 1980 and to date have paid over a dozen visits, each lasting two to seven days. All my visits except one to the island were during the season of fair weather. In 1994 two nature lovers from Dhaka (Bangladesh) and I visited the island in July amidst bad weather conditions. We again went to the island in December-January 1994-95 but failed to visit it in August 1995 and July-August 1996 due to inclement weather conditions. My last visit to the island was for three days in November 1996.

During my sojourn on the island I normally walked across the island, sometimes following the coastline and occasionally criss-crossing the main island. In the process I noted wildlife of the island by visual observations, checking fish catch of the islanders and taking note of the fishes that land on the makeshift fish market of the island at Uttar Para. I tried to keep photographic records of both the plants and animals on the island.

At the time of our visit in July 1994, we came across half a dozen teenaged anglers returning from an angling trip from Siradia. Also several villagers were engaged in fishing among the boulders in Dakshin Para with their cast nests. Their catch included several species of fish that looked unfamiliar to me, so I photographed them. Later on, we also tried watching the fishes in their natural surroundings. The measurements of the specimens were deduced from the photographs. The species list was forwarded to several ichthyologists in Bangladesh and only one replied with definite suggestions (Kader, pers. comm.). The species identification was aided by the fisheries experts at the Marine Fisheries Resources Center at Umm-al-Qawain, U.A.E. Several guide books were used to identify the fishes (Anon. 1977, 1982, 1986; Carasson 1977, Chhapgar 1989, Day 1878, Grant 1985, Madsen 1975, Masuda *et al.* 1984, Munro 1955, Randal *et al,* 1978, Sirimontaporn 1984). Names of the fishes mostly follow those given in Carasson (1977) and Munro (1955).

RESULTS AND DISCUSSION

We took nearly 25 photographs, covering 10 species of the marine fishes of St. Martin's Coral Island. Six species had not been reported from the coastal waters of Bangladesh part of the Bay of Bengal (Gafur 1976, Hussain 1970, Khan *et al.* 1995, Rahman 1989, Quddus and Shafi

1983). At least four other species that had been considered earlier as rare or uncommon were also found in Coral Island. Descriptions and ecological notes on all 10 species of fishes are given below:

1. Red Soldier or Crimson Squirrel Fish: *Sargocentron rubrum* (Forskal) (=*Holocentrum rubrum* Bleeker 1877), Fam. Holocentridae: A red fish with 8 silvery white longitudinal bands and three white vertical bands behind the eye, covering both the preopercle and opercle. All fins and head are also reddish. The short snout is pointed while the eyes are very large. The tail is forked with two lighter portions bordered marginally and centrally by darker lines. The specimen was about 14 cm, while the maximum recorded length is 20 cm (Day 1878). It was caught by cast net from the rocky intertidal zone in Dakshin Para. Not a common species.

2. Eleven-banded Cardinal Fish: *Apogon endekataenia* Bleeker. Fam. Apogonidae: A small, colourful coastal fish with pronounced eyes, appreciably long peduncle and a black blotch at the base of the tail. There are at least 10 longitudinal bands, half of which are reddish-brown and others are lightly coloured. One dark and broad band starts at the snout, passes over the eyes and the body, ending at the notch of the forked tail. Lateral line is prominent. Ventral fin short and does not reach the anal fin. All fins are reddish-brown. Two specimens measured 8 cm and 9 cm. Rather uncommon among the coral and other boulders. Caught by cast net from the intertidal region of Dakshin Para.

3. Sword-Lipped Wrasse: *Choerodon robustum* (Gunther) (= *Xiphocheilus robustus*). Fam. Labridae: This fish attracted my attention as it resembled the parrot fish we see regularly in Dubai market. Both the upper and lower jaws are equipped with tusk-like teeth, hence the other name **Red Tusk Fish.** The fish when dead was red and faded red with white jaws and tusks, and reddish fins. The eyes were also red, with yellow iris. The tusked teeth are meant to cut out corals for eating. The specimen measured *c.* 24 cm. It lives along the rocky shore of Coral Island. Uncommon. Caught by the villagers using a cast net from the boulder strewn areas of western side of Dakshin Para.

4. Moon or Green Wrasse: *Thalassoma lunare* (Linnaeus). Fam. Labridae: Quite a colourful fish. The body is lanceolate and laterally compressed, with continuous dorsal and anal fins that are longitudinally banded black, red and blue. The greenish-yellow body, reddish head and operculum traversed by blue stripes and blue, red and yellow tail look vivid. The tail is forked, both ends of which extend so far backwards that the centre takes the shape of a U or half-crescent, that is yellowish. The name 'moon' wrasse has been derived from this shape of the tail. It lives among sand or coral stones and base rocks. Some are also present in the live corals. The fish was about 18 cm long. Caught by anglers from the rocky intertidal zone in Siradia.

5. Javan Wrasse or Rainbow Fish: *Halichoeres javanicus* (Bleeker). Fam. Labridae: Less colourful than the sword-lipped wrasse but looks reddish brown from snout to tail with lots of green, while the chin, throat and abdomen are white. Teeth more or less similar to the sword-lipped wrasse, but much smaller. There is a prominent black spot at the base of the orangish pectoral fin and orangish markings over the head, nape and cheek (opercles) are prominent. Both the dorsal and anal fins are variously marked over the basic green colour. There is a distinct black spot or ocellus between the base of the 5th and 7th (out of 9) dorsal spines. Eyes red with bluish rings. Tail rounded. The specimen measured *c.* 12 cm and was caught by anglers from Siradia.

6. White-tailed or Red-tailed Surgeon Fish: *Acanthurus fuliginosus* Lesson (=*Acanthus matoides, A. xanthopternus*). Fam. Acanthuridae: A grey-brown oval shaped coastal fish with a short but tubular mouth. The pectoral fin is partly yellow and the forked tail base is marked by a broad white band. Both the dorsal and anal fins have longitudinal, dark, bluish bands. From behind the pectoral fin to the peduncle the body is marked with bluish striations. An oblique yellow band in front of the eye and a slight depression over it are clearly visible. There is a single spine over the peduncle. It was caught by cast net from the rocky areas and measured 21 cm. Not a common fish.

The following species (7-10.) are rather uncommon in our waters. They are not traditionally caught in the fishing gear but by cast nets or caught by anglers. They are apparently more common in the rocky near-shore and coral bearing areas of Coral Island than in the open sea.

7. Rosy Snapper: *Lutjanus lutjanus* Bloch, Fam. Lutjanidae: It is the nominate race for the genus and was founded by Bloch in 1790. The name seems appropriate as the sides of the body of the fish have rosy to reddish lines each of which is separated from the next by a lighter one. Red lines also criss-cross the area ahead of, behind and under the prominently white eyes and extend up to the opercles. Those over the lateral line are rather oblique, almost up to the base of the soft portion of the dorsal fin, and then become straight till the end of the soft fin. Back olivaceous. The forked tail is dark with light red border. Upper canine teeth are prominent and the fish had no ocellus or black spot over the body. The specimen measured about 13 cm and was caught by cast net. An uncommon species. Khan *et al.* (1995) have reported it for the first time from Bangladesh.

8. Ashen Drummer *Kyphosus cinerascens* (Forskal). Fam. Kyphosidae (Sparidae): A silvery grey, perch-like, rock-dwelling coastal fish with an elongated caudal peduncle, dark eyes and fins, whitish bands over the preopercle and opercle. The snout is short and dark. Interorbital area, opercle and preopercle covered by smaller scales. The specimen was caught by anglers from the rocky intertidal zone. It was *c.* 22 cm long and Hussain (1970) reported the species for the first time from Bangladesh.

9. Two-eyed Wrasse or Speckled Rainbow Fish: *Halichoeres marginatus.* Fam. Labridae: This is another colourful marine fish that abounds in the rocky shores of St. Martin's Coral Island. It is laterally compressed and rather pear-shaped. The colour of the specimen on my palm was dominated by black and blue. The most distinctive feature seemed to be the yellow patch on the blue-black pectoral fin. Each scale on the body had a dark patch, which over the back, shoulder and head formed continuous and organised lines or streaks. The continuous dorsal and anal fins had blue-edged marks. The tail was rather rounded and variously coloured. Eyes greenish-blue. The specimen caught by the anglers resembled the description of the type specimen more than the one collected from the Andamans and illustrated by Day (1878). It measured *c.* 16 cm. Hussain (1970) is possibly the first to report it from Bangladesh.

10. Zebra or Blue Angelfish: *Pomacanthodes semicirculatus* (Cuvier). Fam: Pomacanthidae. The specimen is a juvenile caught from the tiny pools formed in the rocky intertidal region of Siradia. It is bluish-black with prominent white, broad bands alternating with blue ones, peduncle banded but tail bandless and almost whitish. The posterior white bands end in the anal and dorsal fins. Body shape deep as in other angelfish and measured 4.7 cm. A second specimen was 2.4 cm. They were caught by children with the help of a cloth net. This species is uncommon, but a second species **Ringed Emperor Angelfish** (*P. annularis*) is common around the island. Hussain (1970) at first considered the former as uncommon but later as common. Adults of these fishes may be present in deeper water while the fingerlings seem to prefer the rocky intertidal region.

In addition to the above, I had also noted a couple of species of Blenny in the rocky and coral pools at Uttar Para, Dakshin Para and Siradia. I do not think that this has yet been reported from the country.

Some of the people of Coral island are traditionally not fishermen but farmers or farm labourers. They generally fish with cast nets and other smaller fishing gear. Their daily fish catch rarely exceeds 2 kg, barely sufficient for the daily requirement of a family of five or six. Teenagers also go fishing with rod and line to bring in sustenance level food for their families. To reach Siradia they walk nearly 16 km to and fro. These two groups of islanders generally do not sell their catch in the market but keep it for home consumption. Such fishing is more prevalent during the monsoon when inclement weather compels the people to remain indoors, making them jobless. The fish usually caught through these non-traditional methods and on non-commercial basis provide subsistence to the poorer section of the population of Coral Island. Therefore, to better the economic conditions of the local people, this non-traditional fishing is quite important and needs to be encouraged. As far as the marine fishes of Bangladesh are concerned, there is only one paper by Hussain (1970) that provides a complete list. This even includes certain genera without mentioning species that are likely to be present in Bangladesh. Six species of fish recorded here find no mention in his work or those of Khan *et al.* (1995), Rahman (1989) and Quddus and Shafi (1983).

I believe that, in the past, both earlier and recent fish experts in Bangladesh depended almost entirely on the fish samples caught in their research vessels or on the samples collected from the market for preparing their lists of fishes of the country. So species that abound in the rocky shores and live in coral beds of Coral Island were possibly missed, simply because these did not appear in the fish markets.

Further investigations are needed to get an overview of the marine fishes of St. Martin's Coral Island of Bangladesh. Scuba diving may also reveal new records of fish and invertebrate species. It may also highlight the abundance of fish species preferring the rocky and coral areas. This is a new avenue for fishery experts of Bangladesh, which they may venture into in the immediate future.

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ACTIVITY PATTERNS AND TIME BUDGETS OF THE PHEASANT-TAILED (*HYDROPHASIANUS CHIRURGUS*) AND BRONZEWINGED (*METOPIDIUS INDICUS*) JACANAS[1]

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(*With four text-figures*)

Key words: *Metopidius indicus, Hydrophasianus chirurgus,* activity pattern, time budget, ethogram.

The activity patterns and time budgeting of both the pheasant-tailed (*Hydrophasianus chirurgus*) and bronzewinged (*Metopidius indicus*) jacanas were studied in different seasons. Ethograms for these two species were compiled. These species employed two types of feeding methods: 'feeding while ducking' and 'feeding while walking'. The time allotment in all seasons for feeding was high, followed by maintenance, except in the case of the breeding pheasant-tailed jacana. A consistent feature of the diurnal activity pattern of the pheasant-tailed jacana was a slight increase in feeding activities corresponding to the low maintenance activity during the evening. The bronzewinged jacana had a consistent diurnal activity pattern: two feeding bouts, between 0700 and 1100 hrs and between 1300 and 1500 hrs, punctuated by a maintenance bout. Statistically significant difference and similarities among seasons in the feeding and maintenance were noted in both species.

INTRODUCTION

The behavioural patterns of animals are the product of their interaction to external biotic and abiotic stimuli. Time or activity budget is a quantitative description of how animals apportion their time for feeding and other activities (Baldassarre and Bolen 1994). Although some types of behaviour require more time and energy than others, the optimizing paradigm predicts that the individual performs at the most opportune time (Smith 1976). Because of the chance component, the underlying rhythm of any behaviour repertoire can be modified in most cases and, therefore, the behavioural pattern is probabilistic.

Examining the influences of temporal and environmental factors on a species' time budget will enable us to understand the ecological significance of behavioural pattern (Boettcher and Haig 1994). Time-activity budgets have been reported in many species of water birds, especially ducks (Baldassarre and Bolen 1994), geese (Raveling *et al.* 1972: Burton and Hudson 1978; Eberhardt *et al.* 1989; Marquiss and Duncan 1994) and waders (Boettcher and Haig 1994, Eguchi 1988). There are a few studies from India on ducks (Sridharan 1989) and other taxa of water birds, namely purple moorhen (Bhupathy 1985) and coot (Jayaraman 1985). The time activity budget has not been studied in any jacana species so far. This paper presents the results of a study on the activity patterns and time budget of the pheasant-tailed *Hydrophasianus chirurgus* and the bronzewinged *Metopidius indicus* jacanas occurring in the Indian subcontinent and a comparison of patterns with those of other water birds. An attempt was

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also made to find out the adaptive significance of the activity pattern followed by the jacanas.

STUDY AREA

The study was conducted in a wetland, Keoladeo National Park situated in the Indogangetic plains (27° 7.6' to 27° 12.2' N lat, 77° 29.5' to 77° 33.9' E long.). The total area of the Park is 29 sq. km with a waterspread area of 8.5 sq. km. The aquatic portion of the Park has been divided into various unequal compartments or blocks by means of dykes.

METHODOLOGY

The pheasant-tailed and bronzewinged jacanas were studied from 1986 to 1987 covering three major seasons, namely monsoon, winter and summer. The focal animal method (Altman 1974) was used, sampling at predetermined intervals of 15 minutes. In one hour, two such samples were taken. All observations were made from dykes, using binoculars (10x) and telescope (20x). The duration or the bout of activities was measured with an electronic stopwatch. The average length of prolonged activities such as 'feeding while walking' and 'feeding while ducking' could not be calculated from the data, as the activities flowed over the sampling duration. Short duration activities comprised calling, flying, chasing, head scratching, wing flapping, running, preening, alert and attack. Some of these activities occurred in a combined form. For instance, chasing mostly consisted of flying and calling, and could not be separated. Where separation of activities was practically difficult, such activities are reported in combined form.

One full-day observation was taken either at a stretch or in two or three days. The observations on second or third day were started from the time they were called off on the previous day. The identity of the bird on the second day was ascertained by its parochial nature. At times, it was very difficult and the identification was doubtful. However, in a day-long observation, the same individual was followed and only when it disappeared from sight was another spotted for observation. This happened frequently in the case of the pheasant-tailed jacana, as it often moved away from sight.

Usually, observation started at 0700 hrs and terminated at 1800 hrs. But it varied, depending on the variation in the time of sunrise and sunset, from season to season. Hourly data on each activity was converted into percentages for month-wise comparison.

The activity pattern of the pheasant-tailed jacana was studied over three years and data was pooled into five seasons, whereas the bronzewinged jacana was studied over four different seasons. The seasons were defined with respect to the weather, regardless of the year.

The activities of jacanas were classified into three major groups for analysis, namely feeding, maintenance and alert. Depending on the methods used, feeding is further broken up into 'feeding while walking' and 'feeding while ducking'. The 'feeding while walking' technique was employed when the substrate was rather hard, i.e. thick growth of grass or *Eichhornia crassipes* or *Trapa natans* and 'feeding while ducking' was noted while on floating and submerged vegetation. The maintenance activities include mainly preening and bathing, and 'alert' was when the bird called off an activity abruptly and looked around keenly. The rest comprised flying, walking, calling and agoni stic interactions. The last one included chasing by running or by flying after the intruder. In most cases, the birds uttered a shrill call on taking wing.

Different samples of the same season were pooled, and the activity pattern for that season was plotted, using a locally weighted smoothing procedure (Wilkinson 1988a). The paired 't' tests (Sokal and Rohlf, 1969) were employed for seasonal comparison of activities using SYSTAT (Wilkinson 1988b).

TABLE 1
FREQUENCY AND BOUT LENGTH IN THE PHEASANT-TAILED JACANA

		Bout length (in seconds)			
Activities	Frequency	Min.	Max.	Mean	Sd
Feeding while ducking	65	9.27	900.00	454.40	354.41
Feeding while walking	279	0.68	1719.00	382.11	312.13
Resting	48	0.14	1740.00	238.39	328.62
Preening	173	0.25	900.00	135.78	177.65
Bathing	14	11.00	379.66	101.77	102.37
Chasing	6	2.63	180.00	46.15	72.06
Wing Flapping	2	0.72	78.31	39.52	54.86
Alert	101	0.54	553.00	38.62	68.18
Flying + Calling	9	2.23	107.51	33.31	33.86
Walking	6	3.47	80.00	32.75	33.96
Flying + Chasing	1	30.46	30.46	30.46	—
Freezing	5	1.00	37.87	17.11	15.91
Flying	31	0.10	71.28	14.34	17.51
Calling	13	0.42	67.12	12.44	18.13
Chasing + Flying	1	11.98	11.98	11.98	—
Flying + Calling + Chasing	8	0.03	27.93	11.41	11.12
Running	11	1.64	67.38	10.34	19.10
Head Scratching	14	1.00	43.98	7.08	11.06
Wing Stretching	16	1.73	16.32	4.94	3.74
Hopping	11	0.28	13.51	3.63	3.93
Chasing + Calling	1	0.72	0.72	0.72	—
Being Chased	1	0.32	0.32	0.32	—

TABLE 2
FREQUENCY AND BOUT LENGTH IN THE BRONZEWINGED JACANA

		Bout length (in seconds)			
Activities	Frequency	Min.	Max.	Mean	Sd
Feeding	28	26	1827	888.929	417.243
Brooding	1	833	833	833.00	—
Resting	4	94	690	417.500	245.810
Preening	24	5	1800	266.792	412.148
Freezing	2	45	120	82.500	53.033
Head scratching	7	2	214	35.429	78.782
Alert	11	2	60	25.727	17.533
Hopping	1	24	24	24.000	—
Flying	5	2	24	10.800	8.786
Calling	3	1	19	7.667	9.866
Flying + Chasing	3	5	10	7.667	2.517
Bathing	2	2	13	7.500	7.778
Chasing + Calling	1	6	6	6.000	—
Flying + Calling	1	5	5	5.000	—
Wing Flapping	3	1	3	2.333	1.155
Wing stretching	2	1	1	1.000	0.000

RESULTS

Ethogram of jacanas

An ethogram is the set of behavioural categories that is considered for describing the behaviour of a given species (Haccou and Meelis 1992). Altogether 22 and 16 behavioural categories were identified for the pheasant-tailed and the bronzewinged jacanas respectively. The most frequent category was feeding while walking, followed by preening, and alert for the pheasant-tailed (Table 1) and feeding, preening, and alert for the bronzewinged jacana (Table 2).

The major feeding strategy of the pheasant-tailed jacana was feeding while ducking, indicating its preference for submerged vegetation. The shortest activity (total time spent: 0.03 minutes) of the pheasant-tailed was flying + calling + chasing and that of the bronze-winged was wing stretching, followed by wing flapping (Table 1 & 2). Although the bronzewinged employed two strategies for feeding, as did the pheasant-tailed, they are reported here in a combined form. In the bronzewinged jacana the maximum duration of preening was 1800 seconds, occurring after the bath which can be considered as "preening proper" and the minimum duration of preening was 5 sec.

PHEASANT-TAILED JACANA

In all seasons, the pheasant-tailed spent

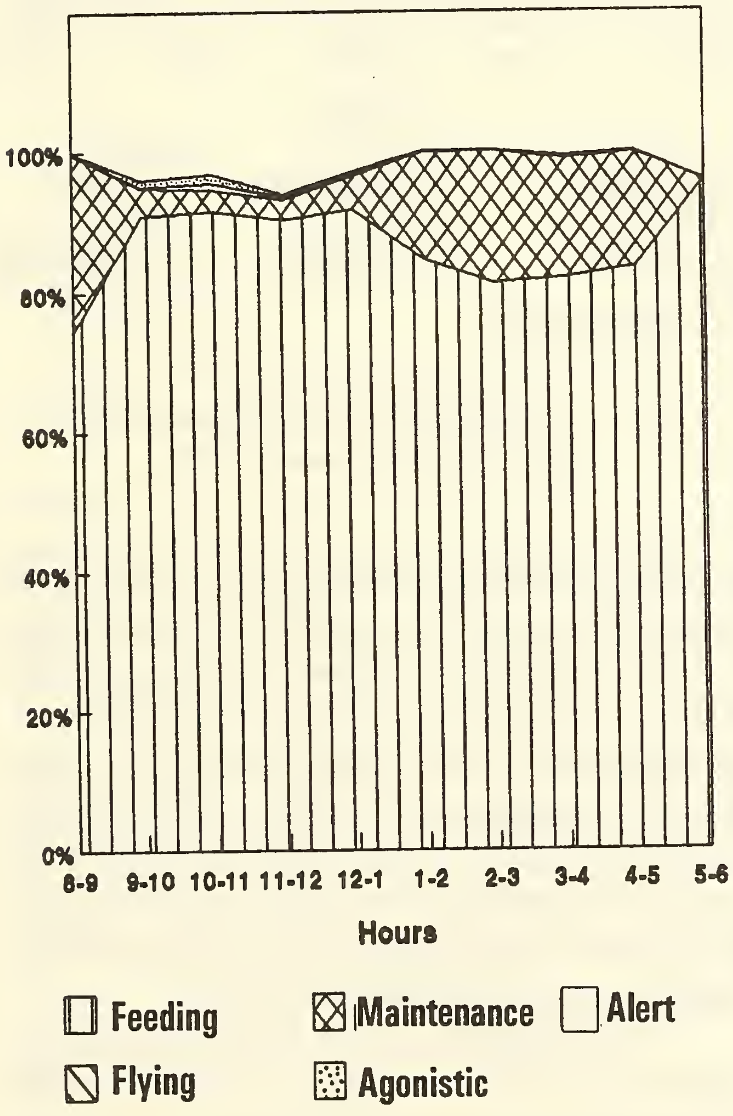

Fig. 1a: Activity pattern of the Pheasant-tailed jacana during monsoon 1986

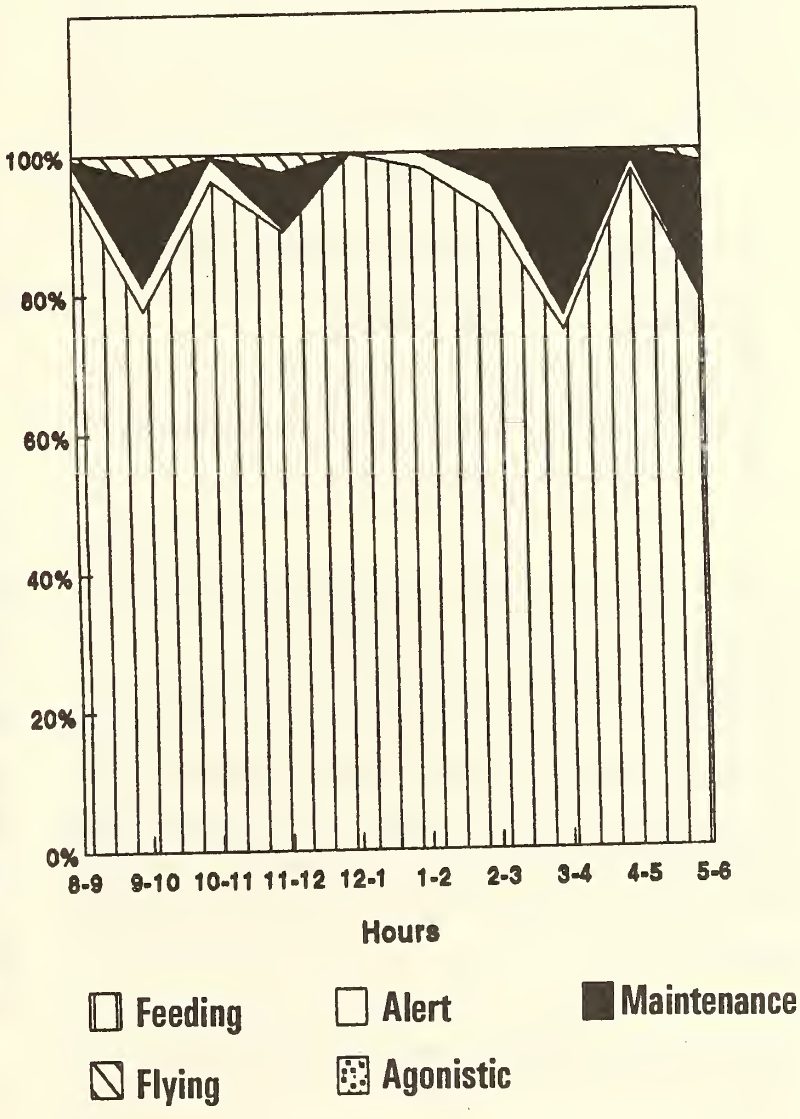

Fig. 1a: Activity pattern of the Pheasant-tailed jacana during winter 1986-87

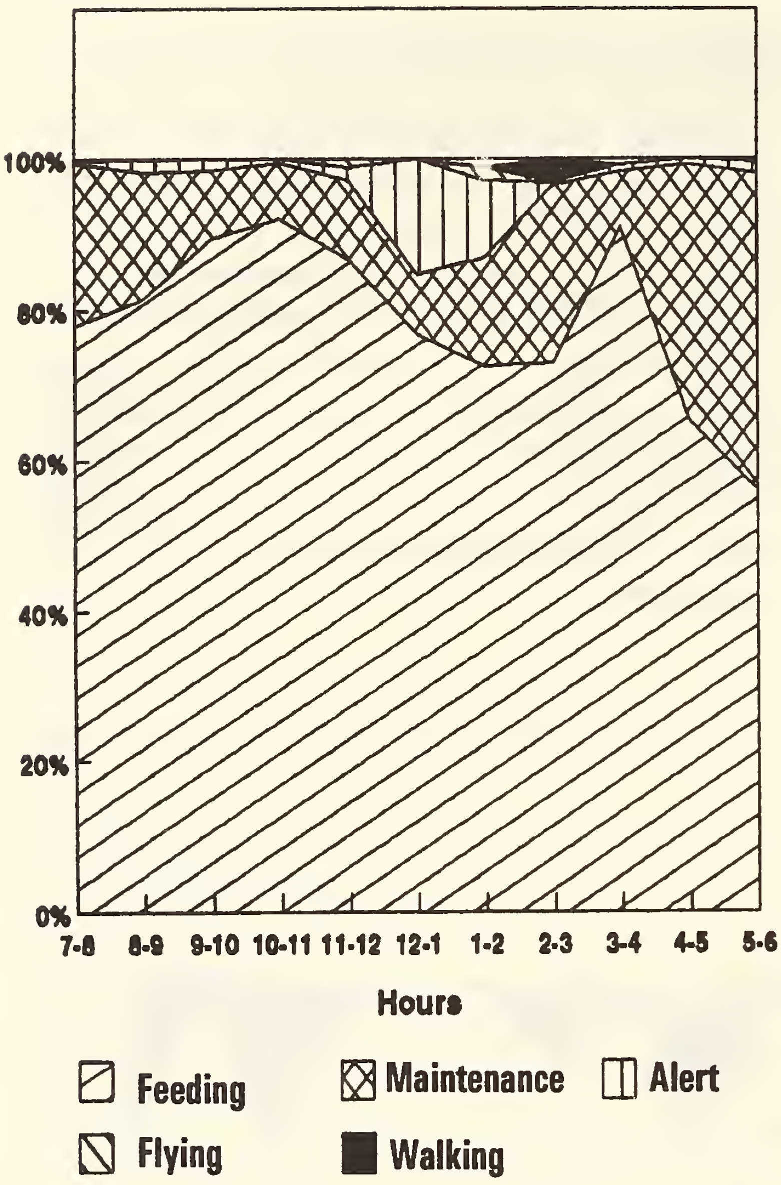

Fig. 1c: Activity pattern of the Pheasant-tailed jacana during summer 1987

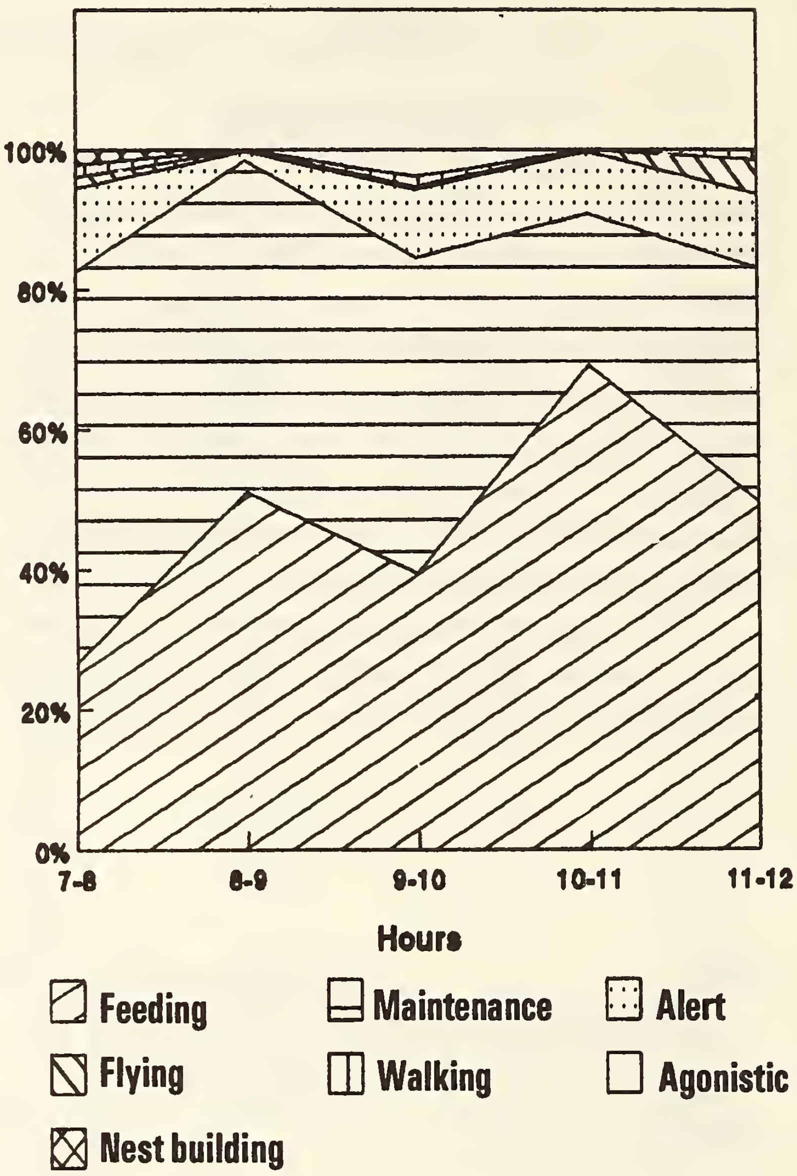

Fig. 1d: Activity pattern of the Pheasant-tailed jacana during monsoon 1987

most of the day time for feeding, followed by maintenance. However, difference in their rhythm of feeding as well as maintenance activities was noticed (Figs. 1a, 1b, 1c, 1d & 1e). The only constant feature was a slight increase in the feeding activities, with a correspondingly low maintenance activity during the evening from 1400 to 1600 hrs in all the seasons (Fig. 2).

Seasonality in feeding and maintenance activities

The pattern of feeding activity in the monsoon of 1987 and winters of 1987 and 1988 was similar, and the pattern in the monsoon of 1986 and summer of 1988 was similar. The pattern of maintenance activity in general was inversely proportional to that of feeding, except in the winter of 1987 (Fig. 2). They began roosting at about 1800 hrs in the winter. Prior to this, they indulged in preening, and flew about for a short duration. The roosting behaviour of the pheasant-tailed jacana could be studied only in one winter, and it was noted that they roost in closed groups in *Eichhornia* patches.

The allocation of time for feeding did not vary between different pairs of seasons except for the monsoon of 1987 (Table 3). This was because during this season observation was made on an individual of a breeding population outside

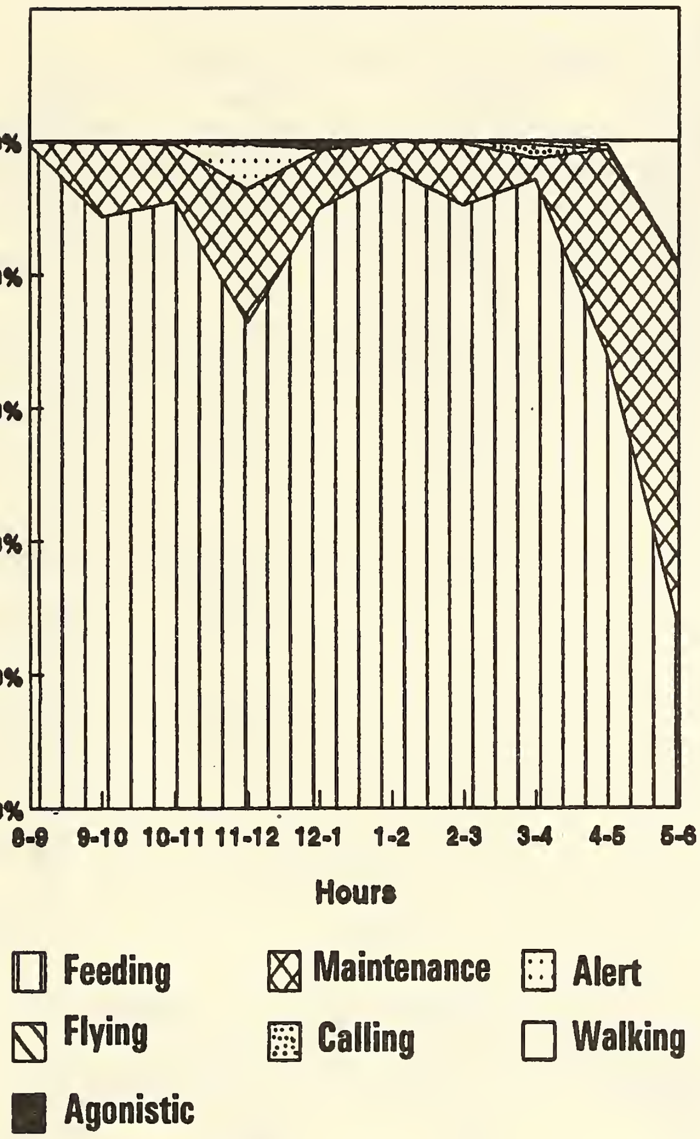

Fig. 1e: Activity pattern of the Pheasant-tailed Jacana during winter 1987-88

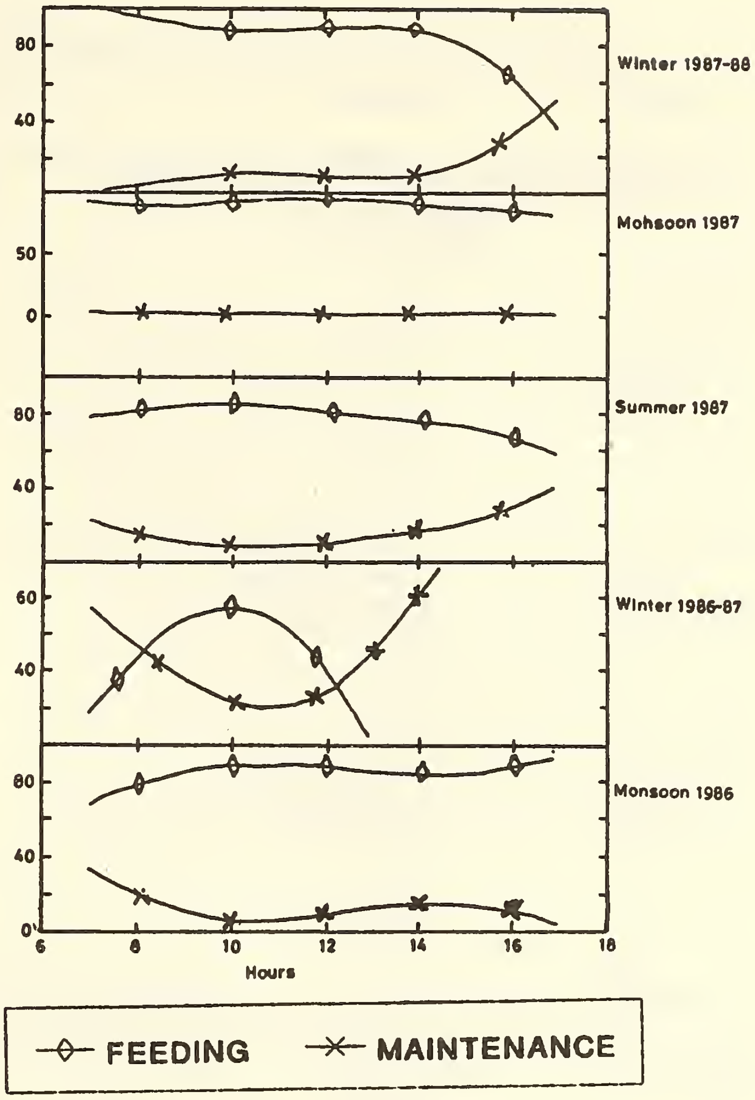

Fig. 2: Diurnal feeding and maintenance patterns in Pheasant-tailed Jacana in different seasons

the Park. The pattern is entirely different while breeding. They spent a great deal of time on maintenance. Apart from this, the allocation of time for feeding varied between the summer of 1988 and winter of 1986-87 (Table 3).

The time allotment for maintenance activity during the monsoon of 1987 also differed significantly from that of other seasons (Table 4). In addition to this, in all other seasons, except between the monsoon of 1986 and the summer of 1988 and, between the summer of 1988 and winter of 1987-88, the time allocation for maintenance activity varied (Table 4).

Monthly time budget

The pheasant-tailed jacana spent a major portion of its time for feeding, followed by maintenance in all months except in July (Table 5).

BRONZEWINGED JACANA

The major activity of the bronzewinged jacana was feeding in all the seasons, followed by maintenance activities (Fig. 3a). These two activities together consumed the major share of their total day time. In contrast to the pheasant-tailed jacana, their activity showed a more or less distinct and consistent pattern in feeding and a corresponding diametrically opposite pattern in maintenance in all seasons (Fig. 4). Feeding peaked between 0700 and 1100 hrs and between 1300 and 1500 hrs, whereas maintenance peaked between 1100 and 1300 hrs. This pattern is almost similar in all the seasons. Thus, there were

TABLE 3
SEASONAL VARIATION IN THE FEEDING TIME OF THE PHEASANT-TAILED JACANA

Season	Statistics	Monsoon 1987	Summer 1988	Winter 1986-87	Winter 1987-88
Monsoon 1986	Mean difference	34.526	8.168	-3.098	4.897
	Sd difference	14.112	14.221	12.794	25.918
	t value	4.893	1.816	-0.766	0.597
	df	3	9	9	9
	P value	0.016	0.103	0.463	0.565
Monsoon 1987	Mean difference		-38.323	-37.434	-35.757
	Sd difference		12.244	7.630	15.143
	t value		-6.999	-9.812	-4.722
	df		4	3	3
	P value		0.002	0.002	0.018
Summer 1988	Mean difference			-11.266	-3.271
	Sd difference			16.255	15.975
	t value			-2.192	-0.647
	df			9	9
	P value			0.056	0.533
Winter 1986-87	Mean difference				7.995
	Sd difference				20.369
	t value				1.241
	df				9
	P value				0.246

TABLE 4
SEASONAL VARIATION IN THE MAINTENANCE TIME OF THE PHEASANT-TAILED JACANA

Season	Statistics	Monsoon 1987	Summer 1988	Winter 1986-87	Winter 1987-88
Monsoon 1986	Mean difference	-28.291	-6.538	8.639	-4.297
	Sd difference	10.019	14.659	8.265	22.047
	t value	-5.647	-1.410	3.306	-0.616
	df	3	9	9	9
	P value	0.011	0.192	0.009	0.553
Monsoon 1987	Mean difference		27.819	34.573	27.131
	Sd difference		8.916	11.796	16.442
	t value		6.977	5.862	3.300
	df		4	3	3
	P value		0.002	0.01	0.046
Summer 1988	Mean difference			15.178	2.241
	Sd difference			12.550	9.423
	t value			3.824	0.752
	df			9	9
	P value			0.004	0.471
Winter 1986-87	Mean difference				12.937
	Sd difference				17.139
	t value				-2.387
	df				9
	P value				0.041

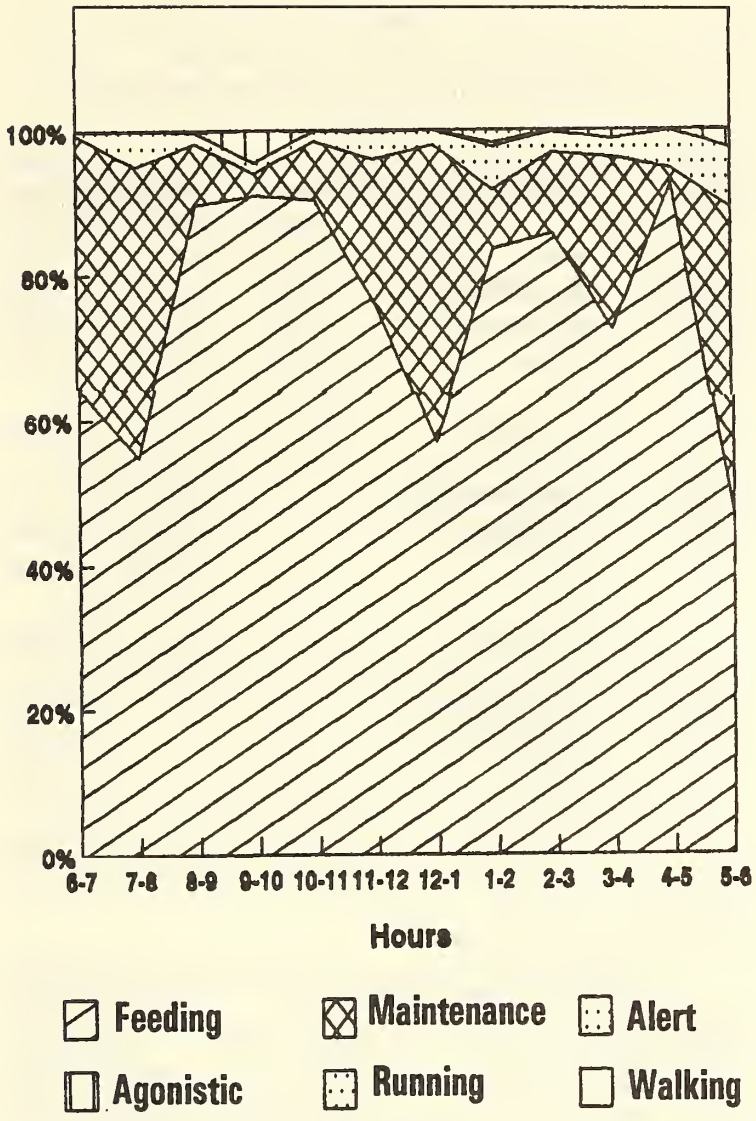

Fig. 3a: Activity pattern of the Bronzewinged Jacana during monsoon 1986

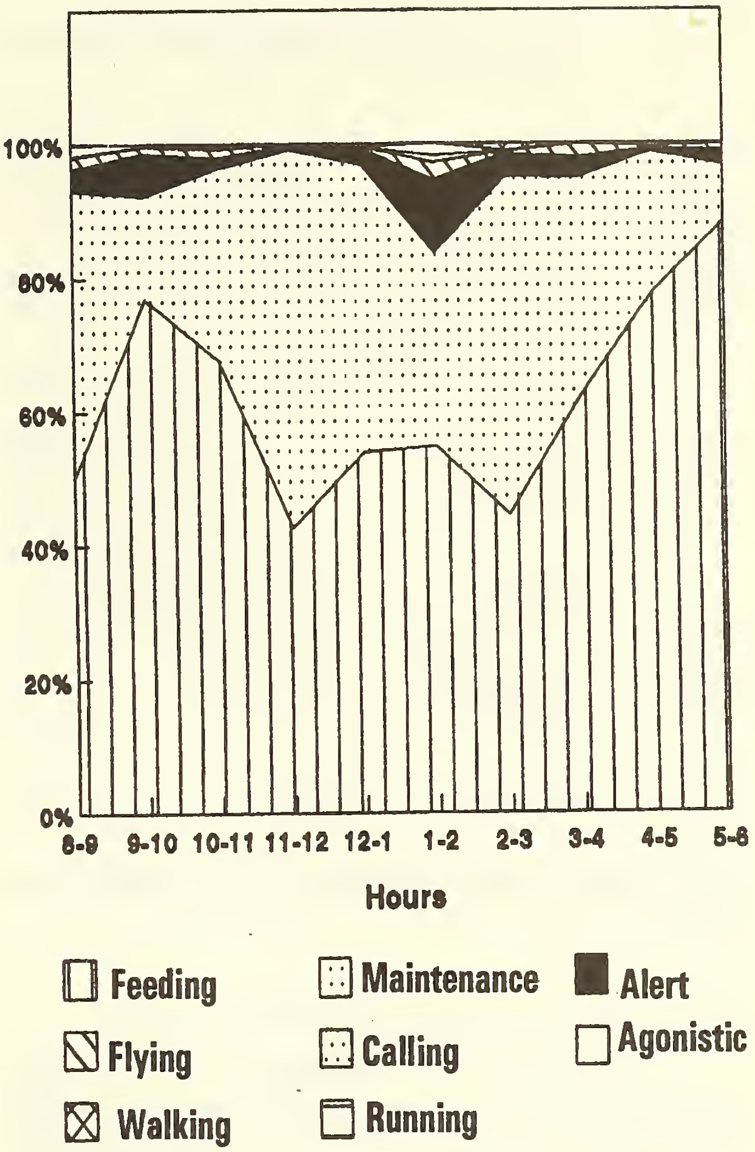

Fig. 3b: Activity pattern of the Bronzewinged Jacana during winter 1986-87

TABLE 5

MONTHLY TIME BUDGETS OF THE PHEASANT-TAILED JACANA (IN %)

Year	Month	Total (Seconds)	Feeding	Maintenance	Alert	Flying	Agonistic	Walk	Call	Nesting
1986	Sep.	24883.00	84.20	10.41	0.00	0.01	0.00	0.00	0.00	0.00
1986	Oct.	16331.91	89.22	9.67	0.37	0.10	0.63	0.00	0.00	0.00
1986	Nov.	26042.21	89.69	7.34	2.05	0.91	0.01	0.00	0.00	0.00
1987	Jul.	18000.00	47.19	40.81	8.44	1.49	0.00	0.89	0.77	0.42
1987	Nov.	16201.68	79.99	17.56	1.78	0.26	0.24	0.16	0.00	0.00
1987	Dec.	16164.01	88.73	8.73	0.27	0.42	0.00	1.83	0.02	0.00
1988	May	21280.00	83.53	11.84	4.25	0.36	0.00	0.02	0.00	0.00
1988	May	22100.00	68.64	26.80	3.24	0.52	0.00	0.81	0.00	0.00
1988	Jun.	21840.00	82.96	14.24	2.05	0.17	0.58	0.00	0.00	0.00

TABLE 6
SEASONAL VARIATIONS IN THE FEEDING TIME FOR BRONZEWINGED JACANA

Season	Parameters	Summer 1988	Winter 1986-87	Winter 1987-88
Monsoon 1986	Mean difference	5.847	-16.143	8.426
	Sd difference	15.901	21.520	17.760
	t value	1.219	-2.372	1.573
	df	10	9	10
	Probability	0.251	0.042	0.147
Summer 1988	Mean difference		-20.429	2.579
	Sd difference		21.233	12.855
	t value		-3.043	0.666
	df		9	10
	Probability		0.014	0.521
Winter 1986-87	Mean difference			21.386
	Sd difference			14.415
	t value			4.692
	df			9
	Probability			0.001

two feeding bouts punctuated by maintenance bouts.

Seasonality in feeding and maintenance

The data when subjected to paired 't' test showed that daily time allocation for feeding in the winter of 1986-87 varied significantly from and was higher than in all other seasons (Table 6).

The time allotted for maintenance in the winter of 1986-87 varied significantly from all other seasons but among the rest of the seasons there was not much variation (Table 7).

TABLE 7
SEASONAL VARIATIONS IN THE MAINTENANCE TIME FOR BRONZEWINGED JACANA

Season	Parameters	Summer 1988	Winter 1986-87	Winter 1987-88
Monsoon 1986	Mean difference	-6.887	16.739	-9.666
	Sd difference	13.686	24.205	20.202
	t value	-1.669	2.187	-1.587
	df	10	9	10
	Probability	0.126	0.057	0.144
Summer 1988	Mean difference		21.722	-2.778
	Sd difference		20.703	15.524
	t value		3.318	-0.594
	df		9	10
	Probability		0.009	0.566
Winter 1986-87	Mean difference			-22.898
	Sd difference			13.508
	t value			-5.36
	df			9
	Probability			0.001

Monthly time budget

Time budgeting of the bronzewinged jacana was studied for nine months (Table 8). Like the pheasant-tailed, it also spent a large proportion of time on feeding, followed by maintenance activities in all months. The time spent for feeding during December was higher than in any other month. Preening and bathing were the major maintenance activities.

Agonistic interactions in the bronzewinged jacana comprised intraspecific interactions and the defence of its young from predators. These

TABLE 8
MONTHLY TIME BUDGETS OF THE BRONZEWINGED JACANA (in %)

Month	Year	Total (Seconds)	Feed	Maintenance	Alert	Flying	Walk	Agnostics	Run	Call
Sep.	86	12605.00	62.38	25.03	1.67	0.00	0.00	0.92	0.00	0.00
Oct.	86	21433.95	82.39	12.48	4.05	0.00	0.03	0.56	0.49	0.00
Nov.	86	18018.42	52.28	43.00	2.04	1.73	0.00	0.52	0.00	0.41
Jan.	87	15300.00	68.57	24.99	4.50	0.79	0.58	0.41	0.08	0.08
Feb.	87	24272.92	61.45	34.95	2.99	0.56	0.02	0.00	0.00	0.04
Nov.	87	17999.94	79.38	15.46	3.51	0.65	0.39	0.00	0.01	0.59
Dec.	87	17100.00	91.99	6.01	0.57	1.39	0.00	0.03	0.01	0.01
May	88	21280.00	83.53	11.84	4.25	0.36	0.02	0.00	0.00	0.00
June	88	21840.00	82.96	14.24	2.04	0.19	0.00	0.57	0.00	0.00

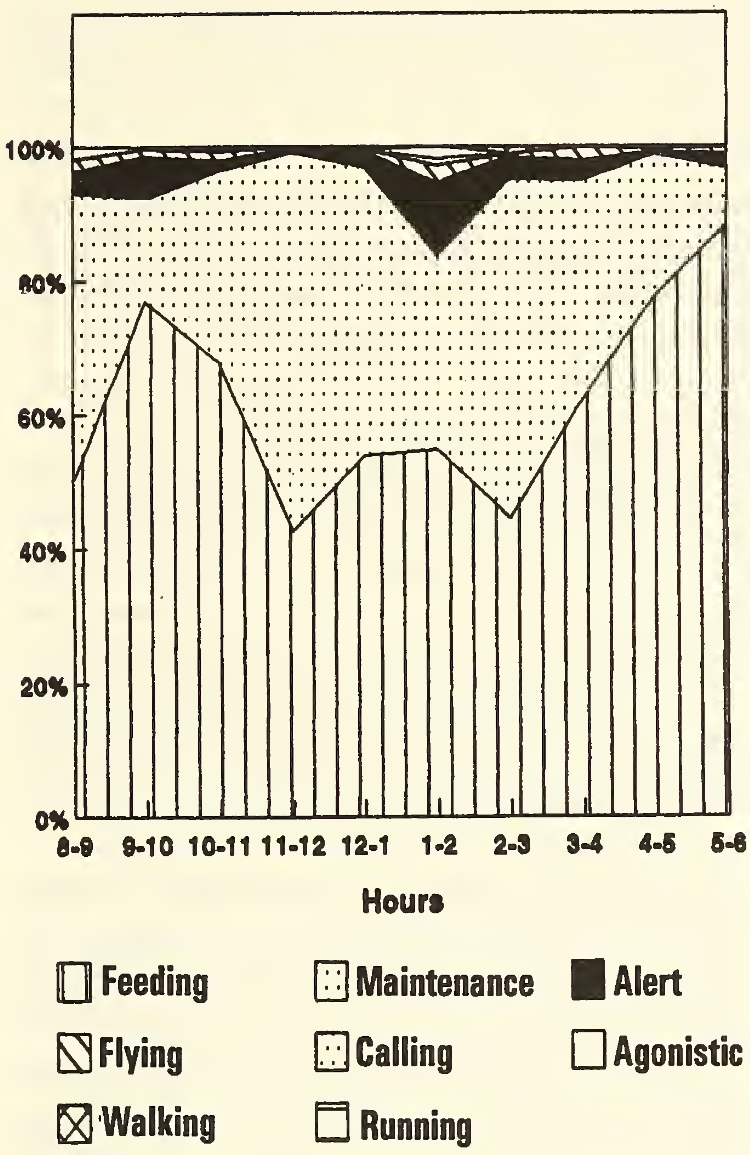

Fig. 3c: Activity pattern of the Bronzewinged Jacana during winter 1987-88

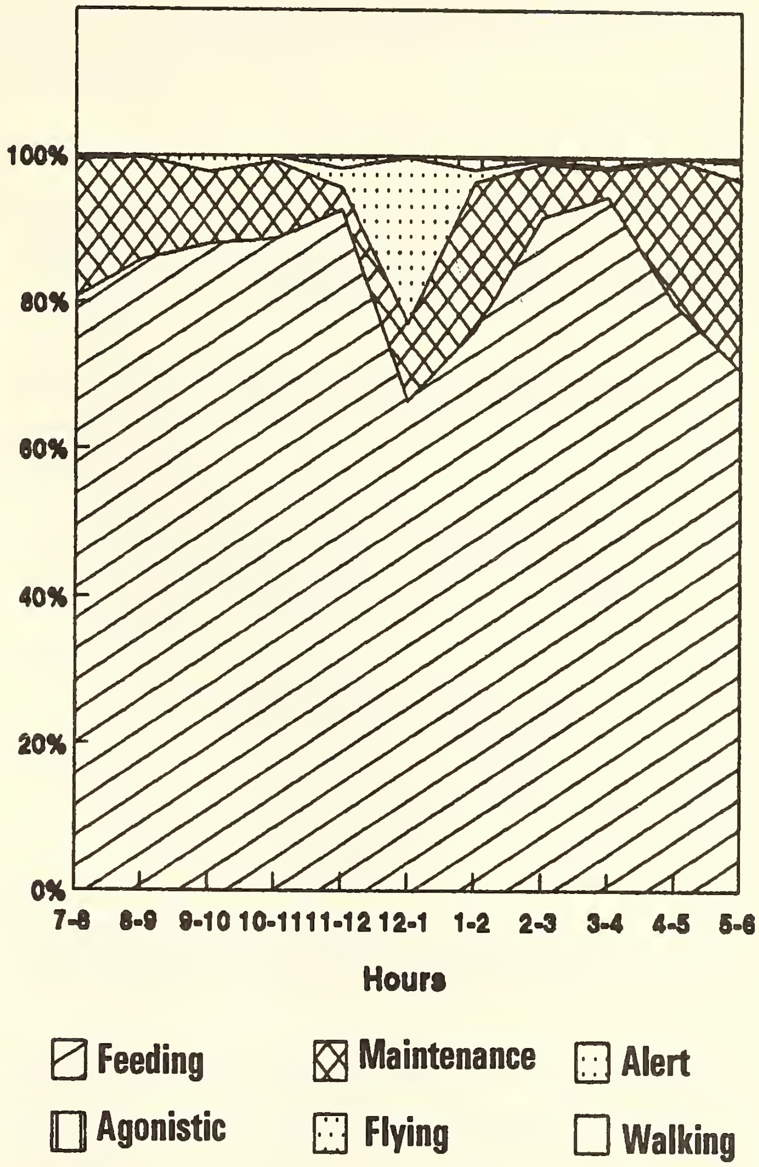

Fig. 3d: Activity pattern of the Bronzewinged Jacana during summer 1988

were given more time in the breeding season and after, till the juveniles dispersed. They chased the intruders either by flying or running after them. Usually they produced a chain of shrill calls, like an electronic alarm clock, with intermittent gaps. Each unit of the call is of very short duration.

Discussion

Most organisms apportion their time for different behavioural activities. The optimal budgeting of time and energy between foraging versus non-foraging activities is, evidently, profoundly influenced by the circadian and seasonal rhythms of physical conditions, as well as those of predators and prey.The pheasant-tailed jacana showed no clear-cut consistent pattern in feeding and maintenance activities in any season. This may be due to the time spent for contingencies having masked the patterns by redistributing the temporal order of normal activity. The activity rhythm, being a probabilistic average, needs a larger number of samplings to reveal its pattern; this might have played a role in the inconsistency shown in our observations on pheasant-tailed jacana. The bronzewinged jacana showed a more or less consistent pattern.

It was observed that both the species set aside a considerable amount of the day time for feeding, followed by maintenance, with the two activities being inversely related. Similar patterns

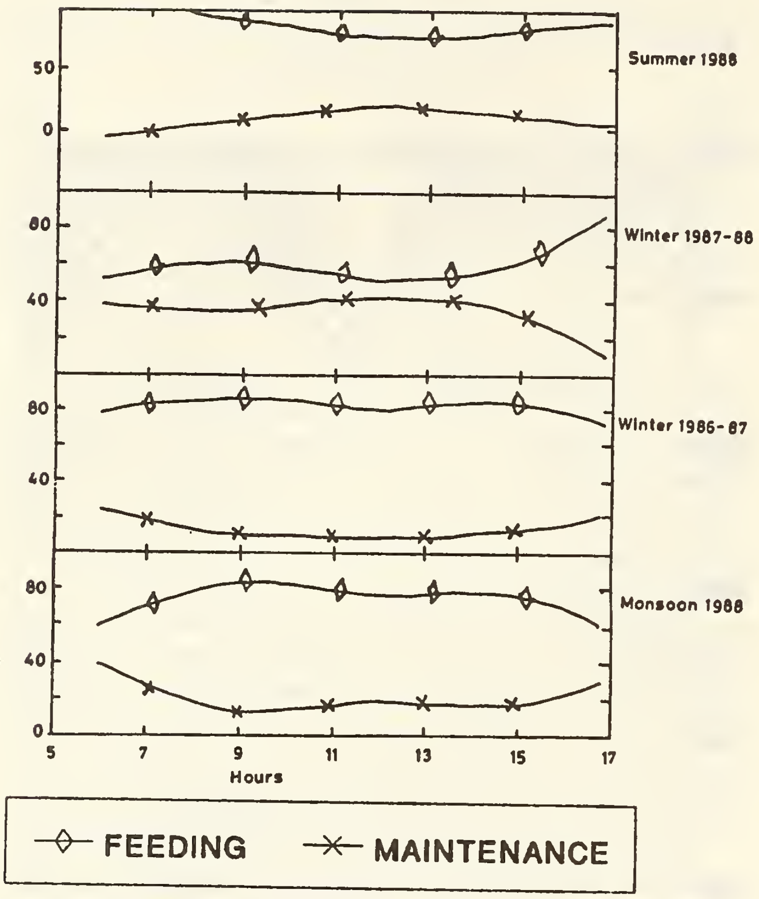

Fig. 4: Diurnal feeding and maintenance patterns in Bronzewinged Jacana in different seasons

were reported in the purple moorhen *Porphyrio porphyrio* (Bhupathy 1985) and coot *Fulica atra* (Jayaraman 1985) from KNP. A review of activity budget of water-fowl by Baldassarre and Bolen (1994) revealed similar trends in waterfowl, with the two activities (feeding and resting) being inversely related. The time spent for feeding and maintenance in the pheasant-tailed ranged from 47-89% and 7-40% respectively, whereas in the bronzewinged it was 61-91% and 6-43%. These values are comparable to those obtained for ducks, geese and purple moorhens. The average time spent for feeding is 20-60% and 30-90% for ducks and geese respectively, and for both resting averages 10-50% (Baldassarre and Bolen 1984). In the purple moorhen, feeding and maintenance values were 59% and 33% respectively (Bhupathy 1985).

Since I have not studied the pheasant-tailed in the nest, other activities like incubation, chick feeding and defence were not recorded. The pheasant-tailed jacana, during the breeding period, spent most of their time for maintenance activities. This seems to be a behavioural response to the productive territory it occupied, in which it need not spend a lot of time searching for nutritious food. The waterfowl selecting food with low water and high energy content, and high availability, spent the least amount of time on feeding (Baldassarre and Bolen 1994). The common teal *Anas crecca* feeding on readily available, high energy waste corn in Texas, expended only 15-20% of their day time budget on feeding activities (Quinlan and Baldassarre 1994). Similar observations were also made on lesser snow geese *Anser caerulescens caerulescens* in Iowa (Fredrick and Klaas 1982).

The availability of nutritious food, suitable habitat and environmental factors (temperature and rainfall) explains the differences in seasonal time allotment for feeding and maintenance in both species of jacanas. The seasonal differences in the time apportioned for feeding and maintenance are not pronounced in the pheasant-tailed jacana, as the time spent for contingencies might have masked the patterns by redistributing the temporal order of normal activity. Brady (1982) states that the circadian control of the daily, repeated, ongoing and normal behaviour rhythm should only be represented as probabilistic average, and does not prevent animals from making instantaneous, ad hoc responses when the need arises.

Nevertheless, the time budgets in jacana species are influenced by habitat conditions, food choice and availability, and environmental factors.

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POSTNATAL GROWTH OF CAPTIVE RHESUS MACAQUES (*MACACA MULATTA*) DURING THE FIRST MONTH OF LIFE[1]

B. Maity and D.S. Rathore[2]

(*With ten text-figures*)

Key words: Neonatal growth, body measurements, *Macaca mulatta.*

Environmental conditions affect the health and development of neonates. The growth rate of 18 neonates of rhesus macaque (*Macaca mulatta*) (7 males and 11 females) born in captivity was determined with weekly measurements of 13 different body dimensions including weight and dental development from day 1 to day 30 of age.The study showed that day 15 was the zenith period of neonatal growth and the growth rates of day 8 and day 30 were almost same in male and female neonates under captive conditions.

Introduction

Biomedical research demands sound health and accurate age of laboratory animals. Data on birth weight, growth rates, sex, feeding schedules, ambient environment etc. are also essential for biomedical research. Many scientists have worked on the effects of laboratory conditions, parental care and feeding schedule in neonatal growth and development of macaques and baboons. (Saxton and Lotz 1990, Sackett and Ruppenthal 1992, Glassman and Coelho 1988). Skeletal growth of specific anatomical structures of rhesus and marmoset monkeys have been studied to determine age in relation to growth rate (Phillips 1976, Michejda 1986). Newell-Morris *et al.* (1991) have also studied postnatal growth and skeletal maturation in *Macaca nemestrina.* Many scientists have developed and adopted many techniques and methods to measure outer body to establish growth rates in relation to age of human fetuses and non-human primates (Schultz 1929, Sirianni and Swindler 1985, Saxton and Lotz 1990, Schneiderman 1993), but no information is available on growth rates of different body dimensions from day 1 to day 30 of age in rhesus macaques under optimum laboratory conditions. We present detailed results of measurements of different body dimensions, growth rates, body weight and dental development from age day 1 to day 30 of rhesus macaques, born and reared under optimum laboratory conditions.

Material and methods

The subjects were 18 neonates (7 males and 11 females) of *Macaca mulatta* born at the National Laboratory Animal Centre, Central Drug Research Institute, Lucknow, India. All the infants were born full term and normally delivered from timed mated mothers housed in individual steel cages, 65 x 76 cm in size, under optimum and hygienic laboratory conditions: 12 hr. light cycle; 24°C ± 3°C temperature and 55 ± 5% relative humidity. All animals were provided with 100 gm pellets (Lipton India Ltd.), 150 gm vegetables, 125 gm bananas, 50 gm citrus fruits, 100 gm brown bread and water ad-lib. Each infant monkey was housed with its mother during the experiment under the same laboratory conditions and evaluated as soon as possible after delivery. Thirteen different body dimensions including weight and dental development were measured for each animal at weekly intervals from ages day 1 to day 30. The infants were sedated using (0.2 mg/infant) Ketamine during restraint for measurements of the following parameters. (Calipers, electric platform balance, measuring board and tape were used for measurements):

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Table 1

BODY MEASUREMENTS (MEAN ± SD) OF INFANT RHESUS MONKEY AT 7/8 DAYS INTERVALS.

Age -	Day 1		Day 8		Day 15		Day 22		Day 30	
Parameters	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Body Weight /gm	416.43 ±17.49	414.55 ±12.74	443.43 ±19.80	440.73 ±14.26	542.86 ±23.70	534.91 ±12.76	623.43 ±24.60	610.09 ±08.20	676.71 ±23.27	656.00 ±10.31
Length of Leg /cm	17.24 ±0.34	16.57 ±0.17	17.57 ±0.34	16.79 ±0.15	18.63 ±0.36	17.64 ±0.15	19.54 ±0.34	18.32 ±0.17	20.04 ±0.33	18.74 ±0.20
Length of Arm /cm	15.62 ±0.31	15.05 ±0.22	16.05 ±0.32	15.31 ±0.22	16.88 ±0.29	15.91 ±0.21	17.59 ±0.33	16.41 ±0.22	18.15 ±0.35	16.77 ±0.24
Length of Foot /cm	5.56 ±0.22	5.23 ±0.19	5.75 ±0.22	5.38 ±0.21	6.24 ±0.27	5.76 ±0.21	6.62 ±0.25	6.09 ±0.20	6.91 ±0.24	6.33 ±0.23
Length of Palm /cm	3.63 ±0.21	3.24 ±0.14	3.91 ±0.21	3.44 ±0.14	4.31 ±0.21	3.76 ±0.14	4.61 ±0.19	3.97 ±0.17	4.81 ±0.20	4.00 ±0.16
Length of Vertex to Tail/cm	32.02 ±0.31	31.73 ±0.54	32.42 ±0.26	32.06 ±0.55	35.88 ±0.27	34.93 ±0.46	38.98 ±0.29	37.36 ±0.70	40.12 ±0.30	38.27 ±0.45
Sitting Height /cm	18.82 ±0.26	18.24 ±0.16	19.66 ±0.26	18.88 ±0.15	21.84 ±0.33	20.70 ±0.18	23.79 ±0.34	22.30 ±0.22	25.21 ±0.38	23.24 ±0.24
Width of Hip /cm	5.30 ±0.14	5.13 ±0.10	5.48 ±0.12	5.25 ±0.12	5.84 ±0.09	5.53 ±0.13	6.17 ±0.11	5.73 ±0.14	6.30 ±0.15	5.79 ±0.16
Chest/cm	11.19 ±0.24	10.89 ±0.29	11.47 ±0.23	11.04 ±0.27	12.03 ±0.20	11.42 ±0.29	12.47 ±0.19	11.70 ±0.31	12.73 ±0.21	11.87 ±0.29
Length : Nose to middle Toe /cm	36.59 ±0.24	35.84 ±0.34	39.74 ±0.17	38.89 ±0.31	43.84 ±0.19	42.82 ±0.53	47.66 ±0.16	46.16 ±0.79	50.12 ±0.12	48.28 ±0.44
Shoulder/cm	5.71 ±0.16	5.55 ±0.14	5.90 ±0.15	5.65 ±0.13	6.57 ±0.14	6.14 ±0.10	7.06 ±0.14	6.47 ±0.10	7.45 ±0.13	6.71 ±0.09
Nipple distance /cm	2.17 ±0.08	2.28 ±0.08	2.27 ±0.05	2.38 ±0.12	2.46 ±0.05	2.58 ±0.12	2.59 ±0.07	2.70 ±0.11	2.66 ±0.10	2.78 ±0.12
Length of Tail /cm	12.86 ±0.27	12.33 ±0.30	13.31 ±0.27	12.67 ±0.32	15.36 ±0.28	14.45 ±0.32	17.12 ±0.33	15.73 ±0.47	17.80 ±0.36	16.22 ±0.39

1. Bitrochanteric width (Hip) - Hip width was measured with each end of the open calipers on the trochanterion laterale and the measurements were taken with the animal in a crawling position.
2. Full length of arm - The distance between the head of humerus and the tip of middle finger. Calipers was used for this measurement.
3. Full length of leg - The distance from the top of the greater trochanter (axis of femur) to the tip of middle toe. It was also measured with calipers.
4. Full length of animal - It was measured in the following two ways:
   a) Vertex to tail - The distance between the vertex and end of tail was measured dorsally with calipers in a straight position of legs, arms and head.
   b) Nose to middle toe - The distance between nose and the tip of the middle toe was measured dorsally in two steps with calipers in a straight position of legs, arms and head.

TABLE 1 (*contd.*)
BODY MEASUREMENTS (MEAN ± SD) OF INFANT RHESUS MONKEY AT 7/8 DAYS INTERVALS.

Age -	Day 1		Day 8		Day 15		Day 22		Day 30	
Parameters	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Fingers Length/cm										
1. Thumb	1.53 ±0.11	1.40 ±0.07	1.56 ±0.13	1.42 ±0.06	1.67 ±0.13	1.53 ±0.09	1.73 ±0.33	1.60 ±0.11	1.76 ±0.11	1.62 ±0.14
2. Index	2.54 ±0.10	2.35 ±0.08	2.72 ±0.11	2.52 ±0.07	3.01 ±0.10	2.79 ±0.10	3.20 ±0.10	2.95 ±0.13	3.25 ±0.10	3.00 ±0.12
3. Middle	3.02 ±0.11	2.84 ±0.12	3.22 ±0.11	3.01 ±0.12	3.48 ±0.10	3.24 ±0.15	3.68 ±0.06	3.40 ±0.15	3.77 ±0.09	3.47 ±0.14
4. 3rd	2.21 ±0.06	1.95 ±0.09	2.35 ±0.09	2.06 ±0.12	2.58 ±0.13	2.23 ±0.11	2.80 ±0.17	2.40 ±0.13	2.87 ±0.13	2.45 ±0.13
5. Little	1.98 ±0.12	1.70 ±0.10	2.15 ±0.16	1.83 ±0.12	2.52 ±0.16	2.08 ±0.11	2.77 ±0.17	2.25 ±0.11	2.90 ±0.11	2.32 ±0.12
Length of Toes/cm										
1. Thumb	1.70 ±0.11	1.47 ±0.06	1.76 ±0.10	1.52 ±0.09	1.84 ±0.09	1.60 ±0.07	1.91 ±0.10	1.67 ±0.06	1.98 ±0.10	1.73 ±0.05
2. Index	2.15 ±0.09	1.96 ±0.05	2.36 ±0.10	2.12 ±0.07	2.71 ±0.08	2.37 ±0.11	3.00 ±0.08	2.58 ±0.12	3.20 ±0.08	2.72 ±0.13
3. Middle	2.90 ±0.12	2.76 ±0.09	3.09 ±0.09	2.89 ±0.12	3.40 ±0.12	3.13 ±0.09	3.67 ±0.14	3.33 ±0.09	3.82 ±0.11	3.47 ±0.10
4. 3rd	2.14 ±0.10	1.98 ±0.09	2.36 ±0.10	2.12 ±0.08	2.71 ±0.09	2.32 ±0.08	3.00 ±0.08	2.47 ±0.11	3.14 ±0.07	2.62 ±0.17
5. Little	1.96 ±0.11	1.81 ±0.09	2.14 ±0.11	1.95 ±0.08	2.91 ±0.10	2.19 ±0.11	3.22 ±0.19	2.31 ±0.13	3.45 ±0.19	2.45 ±0.15

5. Length of fingers - All fingers were measured dorsally with calipers from metacarpo-phalangeal joint to the finger tip.
6. Length of toes - Distance between the end metatarsophalangeal joint to the tip of the toe.
7. Length of palm - Distance between wrist and the beginning of middle finger.
8. Length of foot - From heel to the beginning of middle toe.
9. Chest - Measured using a measuring tape around the whole body just above the nipples.
10. Nipple distance - The distance between the two nipples (paps)
11. Length of shoulder - Distance between heads of the two humeruses. It was measured ventrally with straight position of arms.
12. Sitting height - The distance from head to hip with the animal in a sitting position against the measuring board.
13. Tail length - Tail was measured with calipers from ventral side of body.
14. Body weight - It was measured with an electric platform balance. Growth rates were calculated by Fisher's equation (Fisher 1921) and compared by Mann Whitney U test (Zar 1974).

RESULTS

Table 1 presents the mean ± SD of each parameter measured in our study for male and female neonates. Growth rates were calculated

Table 2

GROWTH RATES (MEAN ± SD) OF DIFFERENT BODY DIMENSIONS OF INFANT MACAQUES AT 7/8 DAYS INTERVALS.

Age-	Day 8th		Day 15th		Day 22nd		Day 30th	
Parameters	Male	Female	Male	Female	Male	Female	Male	Female
Body Weight /gm	0.0089 ±0.0007	0.0086 ±0.0008	0.0288 ±0.0009	0.0255 ±0.0077	0.0197 ±0.0007	0.0187 ±0.0026	0.0102 ±0.0006	0.0090 ±0.0015
Leg/cm	0.0026 ±0.0004	0.0018 ±0.0003	0.0082 ±0.0003	0.0069 ±0.0005	0.0060 ±0.0013	0.0053 ±0.0003	0.0037 ±0.0007	0.0027 ±0.0004
Arm/cm	0.0038 ±0.0004	0.0024 ±0.0006	0.0071 ±0.0005	0.0055 ±0.0004	0.0058 ±0.0002	0.0043 ±0.0006	0.0039 ±0.0003	0.0026 ±0.0008
Foot/cm	0.0050 ±0.0001	0.0038 ±0.0017	0.0115 ±0.0014	0.0097 ±0.0010	0.0085 ±0.0010	0.0078 ±0.0011	0.0052 ±0.0007	0.0048 ±0.0009
Palm/cm	0.0108 ±0.0016	0.0085 ±0.0028	0.0148 ±0.0021	0.0129 ±0.0052	0.0086 ±0.0015	0.0076 ±0.0017	0.0052 ±0.0001	0.0033 ±0.0010
Sitting Height/cm	0.0061 ±0.0003	0.0049 ±0.0004	0.0150 ±0.0006	0.0130 ±0.0008	0.0121 ±0.0004	0.0105 ±0.0006	0.0072 ±0.0003	0.0050 ±0.0005
Hip/cm	0.0048 ±0.0010	0.0031 ±0.0010	0.0089 ±0.0020	0.0074 ±0.0010	0.0077 ±0.0017	0.0050 ±0.0015	0.0025 ±0.0009	0.0013 ±0.0010
Chest/cm	0.0035 ±0.0005	0.0018 ±0.0007	0.0067 ±0.0007	0.0048 ±0.0007	0.0051 ±0.0006	0.0034 ±0.0010	0.0025 ±0.0005	0.0017 ±0.0006
Vertex to Tail/cm	0.0016 ±0.0003	0.0014 ±0.0002	0.0144 ±0.0002	0.0122 ±0.0009	0.0118 ±0.0003	0.0095 ±0.0015	0.0035 ±0.0002	0.0030 ±0.0010
Nose to middle Toe /cm	0.0117 ±0.0004	0.0116 ±0.0002	0.0139 ±0.0001	0.0136 ±0.0016	0.0118 ±0.0002	0.0106 ±0.0019	0.0062 ±0.0002	0.0055 ±0.0014
Shoulder /cm	0.0045 ±0.0009	0.0025 ±0.0007	0.0153 ±0.0012	0.0118 ±0.0014	0.0101 ±0.0014	0.0073 ±0.0010	0.0068 ±0.0001	0.0046 ±0.0013
Nipple distance /cm	0.0064 ±0.0052	0.0065 ±0.0048	0.0112 ±0.0023	0.0131 ±0.0039	0.0072 ±0.0026	0.0069 ±0.0038	0.0033 ±0.0022	0.0036 ±0.0018
Tail/cm	0.0049 ±0.0005	0.0038 ±0.0005	0.0203 ±0.0012	0.0186 ±0.0012	0.0155 ±0.0005	0.0121 ±0.0028	0.0047 ±0.0005	0.0038 ±0.0019

for each individual animal using the following equation (Fisher 1921), rate $\ln(S_2) - \ln(S_1)/\text{time}$, in which 'S' is the individual measurement and the time is the time interval between measurements S_1 & S_2. These individually derived growth rates were then averaged. The mean ± SD of growth rate for each parameter of our study is also presented in Table 2. Comparative graphs of mean growth rates for body weight, sitting height, leg and arm length, palm and foot length, total length of animal (vertex to tail), fingers and toes length (thumb and little) in male and female neonates are presented (Figs. 1 to 10). It has been observed that birth weight and the growth rates of different body dimensions were the same in male and female rhesus macaques from day 1 to day 30 ($P > 0.05$). The zenith period of infant growth in

Table 2 (*contd.*)

GROWTH RATES (MEAN ± SD) OF DIFFERENT BODY DIMENSIONS OF INFANT MACAQUES AT 7/8 DAYS INTERVALS.

Age-	Day 8th		Day 15th		Day 22nd		Day 30th	
Parameters	Male	Female	Male	Female	Male	Female	Male	Female
Fingers/cm								
1. Thumb	0.0025	0.0015	0.0100	0.0103	0.0048	0.0056	0.0021	0.0033
	±0.0043	±0.0040	±0.0030	±0.0049	±0.0045	±0.0044	±0.0036	±0.0038
2. Index	0.0100	0.0101	0.0141	0.0140	0.0072	0.0080	0.0021	0.0022
	±0.0019	±0.0027	±0.0034	±0.0041	±0.0026	±0.0031	±0.0020	±0.0021
3. Middle	0.0091	0.0082	0.0109	0.0102	0.0079	0.0066	0.0028	0.0023
	±0.0030	±0.0022	±0.0023	±0.0017	±0.0023	±0.0023	±0.0012	±0.0024
4. 3rd	0.0088	0.0076	0.0131	0.0114	0.0112	0.0100	0.0031	0.0028
	±0.0031	±0.0036	±0.0023	±0.0043	±0.0034	±0.0029	±0.0021	±0.0026
5. Little	0.0116	0.0101	0.0227	0.0179	0.0130	0.0113	0.0057	0.0039
	±0.0028	±0.0033	±0.0061	±0.0042	±0.0026	±0.0043	±0.0035	±0.0025
Toes/cm								
1. Thumb	0.0048	0.0050	0.0067	0.0075	0.0053	0.0055	0.0045	0.0046
	±0.0045	±0.0048	±0.0030	±0.0037	±0.0036	±0.0043	±0.0031	±0.0036
2. Index	0.0129	0.0113	0.0184	0.0154	0.0142	0.0120	0.0080	0.0068
	±0.0006	±0.0033	±0.0029	±0.0029	±0.0020	±0.0014	±0.0002	±0.0024
3. Middle	0.0088	0.0063	0.0138	0.0116	0.0109	0.0088	0.0052	0.0049
	±0.0050	±0.0021	±0.0029	±0.0027	±0.0018	±0.0002	±0.0018	±0.0018
4. 3rd	0.0135	0.0107	0.0201	0.0186	0.0142	0.0127	0.0057	0.0049
	±0.0057	±0.0038	±0.0032	±0.0034	±0.0020	±0.0029	±0.0021	±0.0013
5. Little	0.0129	0.0122	0.0439	0.0393	0.0144	0.0137	0.0085	0.0068
	±0.0027	±0.0037	±0.0058	±0.0031	±0.0063	±0.0026	±0.0029	±0.0020

both sexes was day 15 and after that the growth rate declined gradually; and the growth rate of day 30 became almost equal to day 8. It has been found that the growth rate of big toe was the same from age day 8 to day 30. Two lower incisors were developed on day 8, but budding started on day 4. Four lower and four upper incisors were found on day 30 in almost all infants.

Discussion

Laboratory conditions affect health and development of animals, and biomedical research demands healthy animals along with data on age, growth rates, feeding schedule etc. Therefore the determination of age of skeletal and dental development and measurement of growth rate to evaluate age and health status of laboratory animals are very essential. Radiographical observations on skeletal development have already been studied to determine age in macaques and marmoset monkeys (Phillips 1976, Michejda 1978, Newell-Morris *et al.* 1991). Different techniques have been reported for outer body measurements in non-human primates and in humans (Schultz 1929, Van Wagenen and Catchpole 1956, Gavan and Swindler 1966, Sirianni and Swindler 1985). Seven different body dimensions have already been measured in

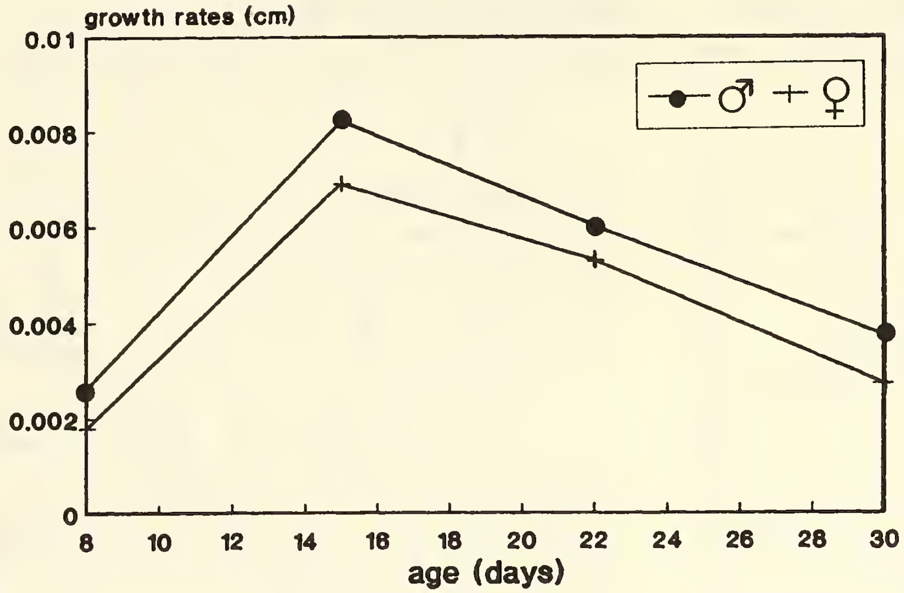

Fig. 1

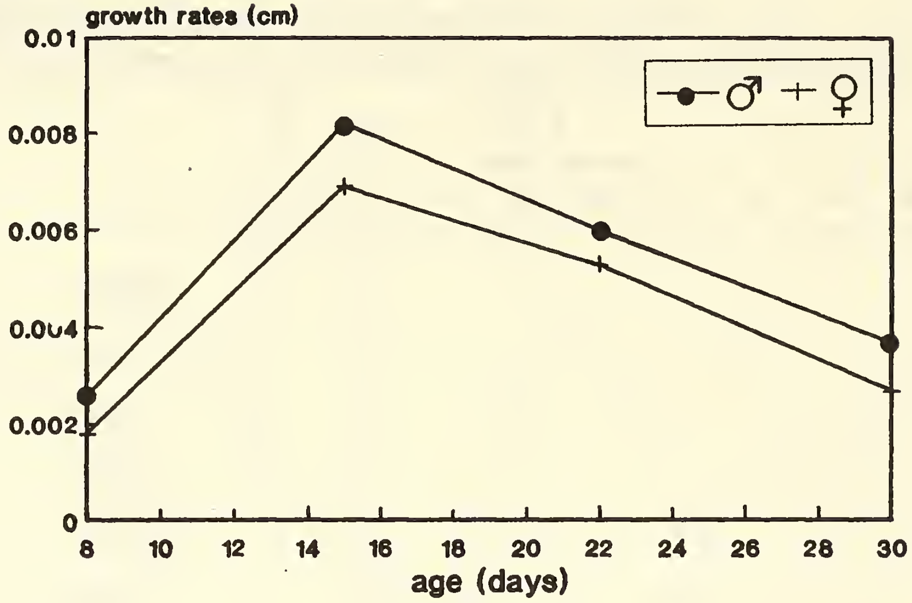

Fig. 2

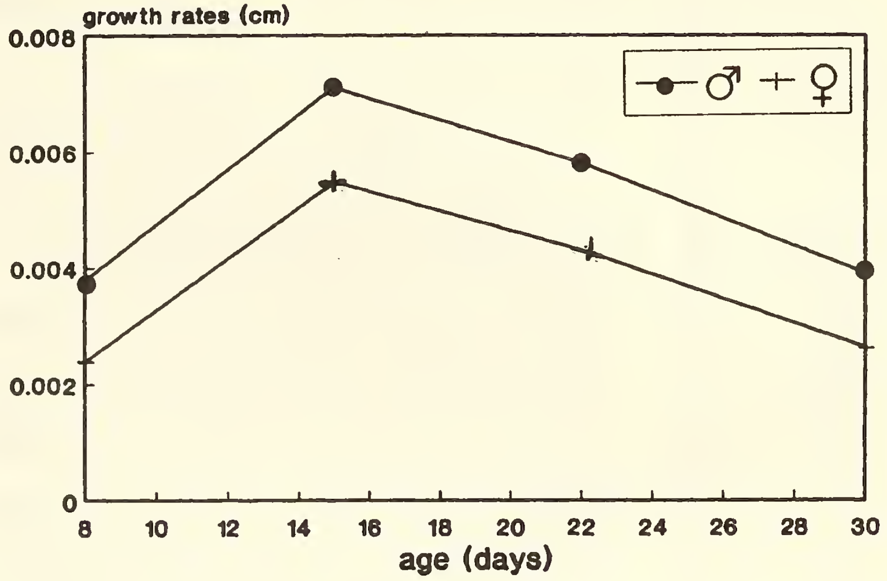

Fig. 3

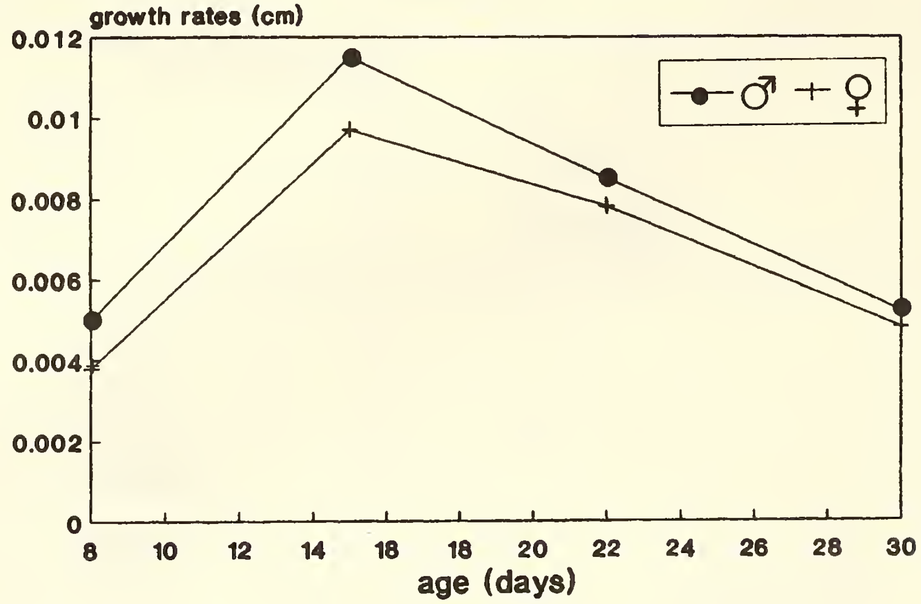

Fig. 4

Figs. 1-4: 1. Comparative growth rates of body weight in male and female infant macaques; 2. Comparative growth rates of leg length in male and female infant macaques; 3. Comparative growth rates of arm length in male and female infant macaques; 4. Comparative growth rates of foot length in male and female infant macaques.

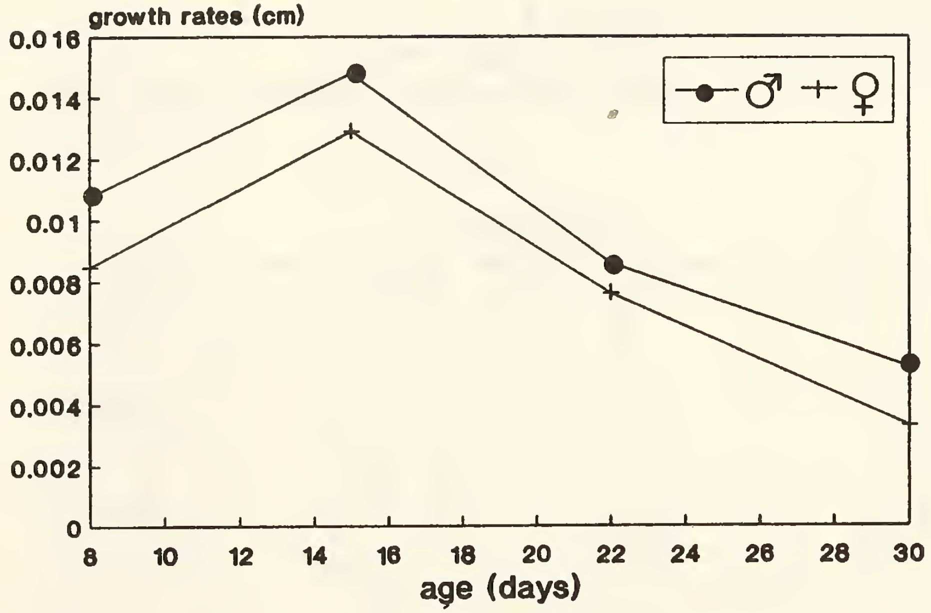

Fig. 5

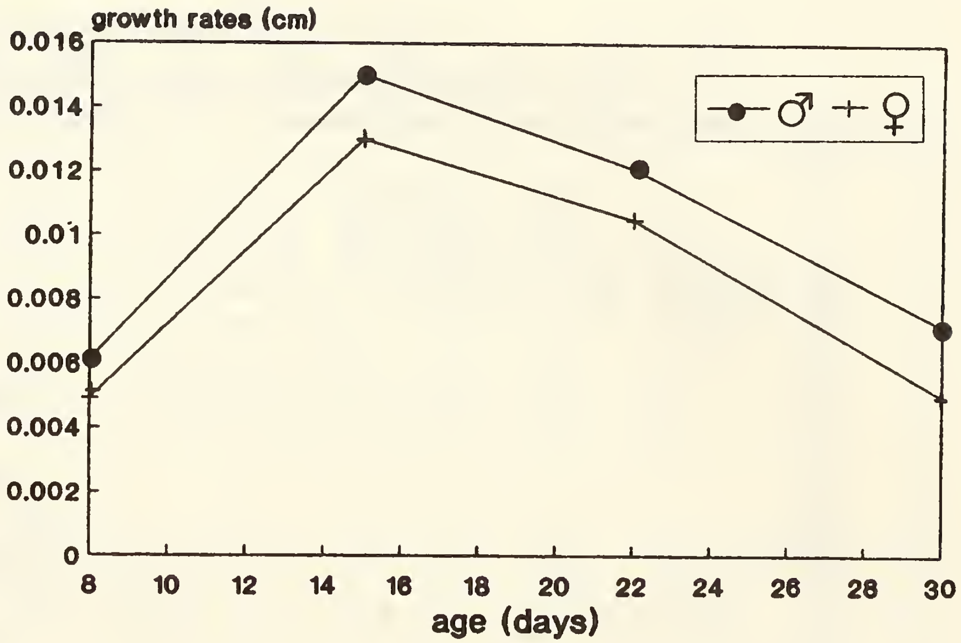

Fig. 6

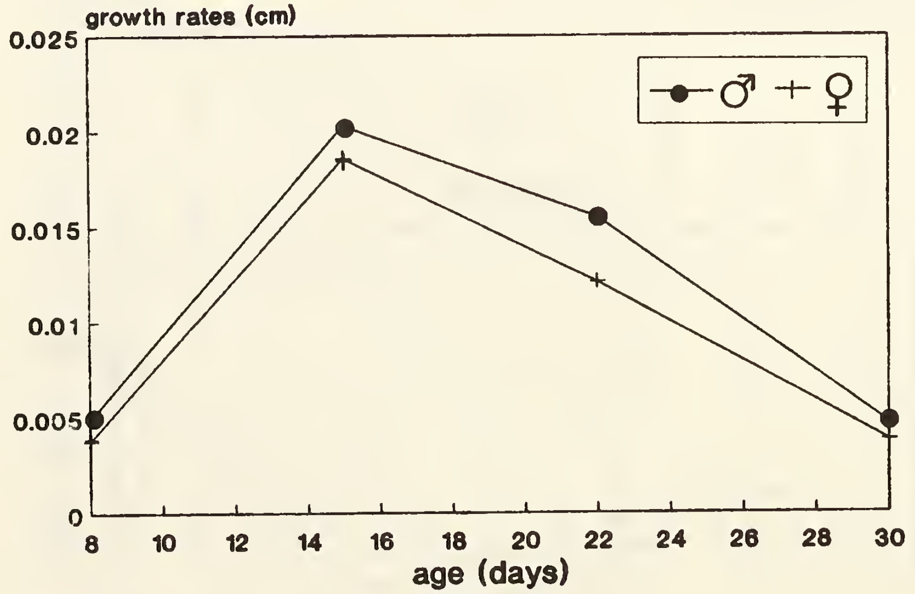

Fig. 7

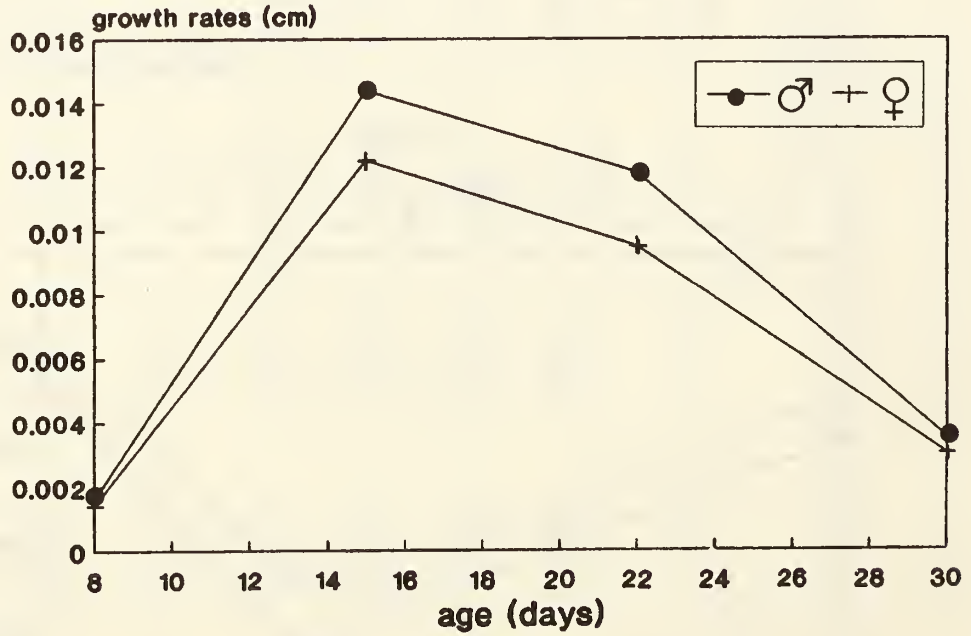

Fig. 8

Figs. 5-8: 5. Comparative growth rates of palm length in male and female infant macaques; 6. Comparative growth rates of sitting height in male and female infant macaques; 7. Comparative growth rates of tail length in male and female infant macaques; 8. Comparative growth rates of body length (vertex-tail) in male and female.

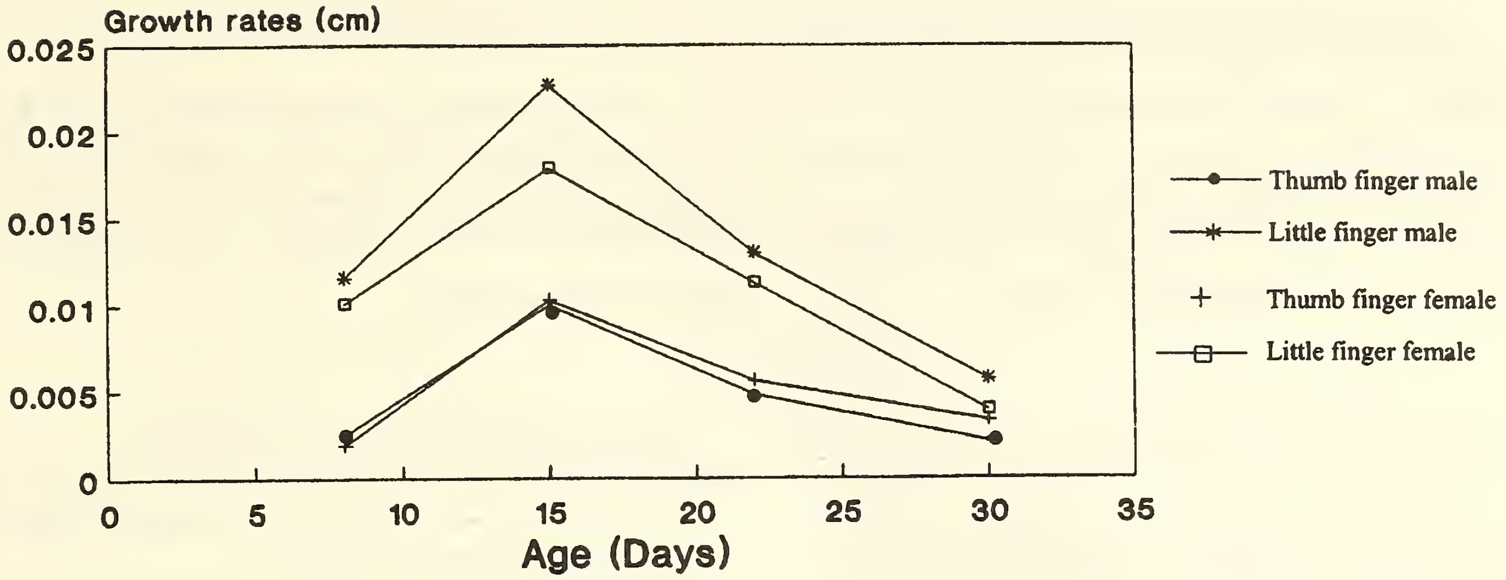

Fig. 9: Comparative growth rates of finger (thumb and little) in male and female monkeys;

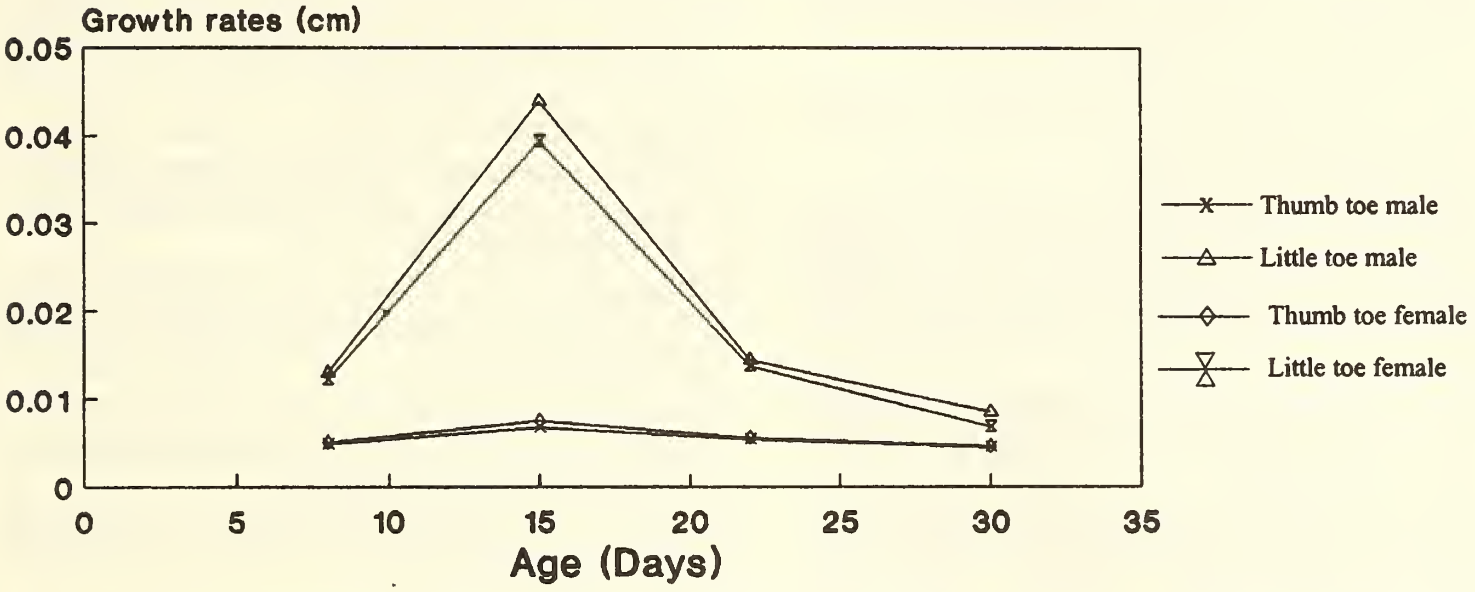

Fig.10: Comparative growth rates of toes (thumb and little) in male and female monkeys.

Macaca mulatta from 1 to 54 months of age (Saxton and Lotz 1990). The techniques for measurement of sitting height and hip width were taken from those described previously (Saxton and Lotz 1990); and some techniques modified for other measurements in our study. Glassman and Coelho (1988) have studied weight growth from birth to adulthood in baboons under controlled environment. Facial growth in rhesus monkey has also been studied by longitudinal cephalometric study (Schneiderman 1993). We have measured 13 body dimensions, birth weight and also observed dental development in rhesus neonates from age day 1 to day 30. Growth rates were also calculated in relation to age and comparative studies of growth rates in male and female monkeys were also performed. We have used Fisher's equation to derive growth rates, (Saxton and Lotz 1990). The data on growth rates and measurements of different body dimensions in rhesus neonates from age day 1 to day 30 were not available in literature. Therefore we were unable to make a comparison with other primate growth data in our study. The basic contribution of our study is to provide standard data on growth rates, along with different dimensions, for quick evaluation of health status and age of captive born macaques.

The results of our study on outer body measurements and growth rates of a sizable number of rhesus neonates indicate that the growth rates of male and female neonates were same upto age day 30 and day 15 was the zenith period of infant growth in captivity. This base line data is very important for scientists in biomedical research.

ACKNOWLEDGEMENTS

We gratefully acknowledge Dr. K.R. Bhardwaj for providing facilities and Prof. R.N. Chakraborty for his excellent advice. We are also thankful to Dr. S.K. Mandal for the statistical analysis of the data.

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FIRST RECORD OF CYPRINID FISH *CHAGUNIUS NICHOLSI* (MYERS) FROM INDIA[1]

W. Vishwanath, W. Manojkumar and K. Selim[2]

Key words: *Chagunius nicholsi* (Myers), new record, India

A cyprinid fish, *Chagunius nicholsi* (Myers) originally known only from Myanmar has been recorded for the first time from India. The species has been collected from the Chatrickong and Maklang rivers of Ukhrul dist. Lokchao river of Chandel dist. and Manipur river of Manipur State. The rivers form the waterheads of Chindwin drainage of Myanmar. A detailed description of the species is given in this paper.

Introduction

The Manipur river draining the central valley of Manipur, India and the Chatrikong draining the eastern part of Ukhrul dist. of Manipur flow out of Indian territory and then join the Chindwin river in Myanmar. The Maklang river draining the southern part of Ukhrul dist. and the Lokchao draining Chandel dist. flows out to join the Yu river in Myanmar, which in turn flows into the Chindwin in Myanmar. These rivers are the headwaters of the Chindwin. As there are few reports on the fishes of the streams and rivers of Manipur, India, draining into the Chindwin river of Myanmar, detailed surveys of the fishes in these rivers were conducted in the period between January 1993 and February 1997.

Myer (1924) described *Barbus nicholsi* based on the specimen collected from the Chindwin river at Monywa, upper Myanmar. Later Rainboth (1986) included the species under the genus *Chagunius* Smith (1938). The fish is so far known to be distributed only in the Irrawady drainage of Myanmar. Our collection included many samples of the species from the Manipur river, the Lokchao river, the Chatrickong river and the Maklang river. Available literature does not provide a detailed description of *Chagunius nicholsi* in respect of morphometry and meristic counts and measurements. This paper reports on the species for the first time from India and attempts to provide a detailed description of the species.

Material and Methods

Fishes were collected with the help of gill nets, sidetracking of streams and dewatering and stupefying with ichthyotoxic plants. The fishes were preserved in 10% formaline. The type specimens were deposited in Manipur University MUMF. Counts and measurements follow Rainboth (1986).

Chagunius nicholsi (Myers)

Barbus nicholsi Myers, 1924. *Amer. Mus. Novit.,* 150: 3-4 [type locality: Monywa, Sagaing, Burma (Myanmar)].

Chagunius nicholsi Rainboth, 1986. *Occ. pap. Mus. Zool., Univ. Michigan,* 712:9-10 (Revision).

Material examined: MUMF 273/3, 194.2-206.9 mm SL, Manipur river at Samolog, 105 km south of Imphal, 25.xii.1993 to 12.i.1994 MUMF 240/4, 108.2-132.6 mm SL, Lokchao river at Moreh, 110 km from Imphal 20.i.1995. MUMF 1301/1, 204.5 mm SL, Maklang river, 130 km east of Imphal, 18.ix.1995. MUMF 1302/1 210.4 mm SL Chatrickong river, 150 km east of Imphal, 2.ii.1997.

Description: D V, 8; P i, 14; V i, 8; A. 5-6; C 1|9/ 8|1; L.1. 45-46; L. tr. 8/1/5; PDS. 15-16. Body elongate, its depth more than head length. Mouth narrow and subterminal. Dorsal fin nearer to the tip of the snout than to the caudal fin base, two rows of scales ahead of the ventral fin insertion, its last simple ray osseous and serrated, its denticle weak and recurved. Pectoral fin developed, pelvic fins do not reach the vent. Anal fin almost in the middle of pelvic and caudal fin base. Caudal fin deeply forked. Lower lobe slightly longer than the upper. Barbels two pairs, maxillary and rostral. Both the pairs are longer than the eye diameter. Eyes large, situated nearer to the tip of the snout than to the end of operculum. Inter-orbital somewhat convex. Snout somewhat broadly rounded and smooth. Scale medium, diamond shaped, circumpeduncular scales 19-20, circumferential scales 34-35. Scales rows between vent and anal fin. Muscular lobes are present on the ventral fin base, rarely on the anal fin base. A detailed account of the morphometric measurements and counts and comparison with the data of the present specimen with those of Rainboth (1986) is given in Table 1.

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Measurement and counts of *Chagunius nicholsi* Myers [mean (range)] are as follows: Body depth 29.55 (26.61-32.5); head length 25.18(23.47-26.9), caudal length 25.8 (23.30-28.3), predorsal length 48.55 (47.51-49.6), dorsal fin height 22.15 (19.9-24.4), dorsal fin length 16.00 (14.8-17.2), pectoral fin length 17.31 (17.30-17.33), pelvic fin length 15.73 (15.53-15.93), anal fin height 17.68 (17.30-18.06) all in percentage of standard length. Head width 50.62 (46.5-54.74), head height at occiput 80.45 (74.5-86.4), eye diameter 23.35 (19.7-27.0), inter orbital space 38.1 (36.9-39.3), pectoral length 72.48 (71.25-73.72), snout length 43.1 (39.5-46.7), caudal peduncle length 70.00 (63.5-76.5), caudal peduncle height 45.3 (43.7-46.9), gape of mouth 30.85 (28-33.7), preoccipital length 87.00 (80.5-93.5), preopercle length 72.95 (70.1-75.8), head depth at pupil 58.95 (55.3-62.6), maxillary barbels 25.2 (22.2-28.2), rostral barbels 25.55 (24.2-26.9) all in head length.

TABLE 1
COMPARISON OF CHARACTERS OF *CHAGUNIUS NICHOLSI* MYERS OF MANIPUR WITH THAT OF IRRAWADY, MYANMAR

Characters	Manipur, India	Irrawady, Myanmar (Rainboth, 1986)
N	9	1
In % of SL		
Predorsal	47.51-49.6	48.6
Body depth	26.61-32.5	32.8
Length of caudal peduncle	16.1-19.4	17.7
Head length	23.47-26.9	23.1
Preocciput length	20.7-24.6	20.5
Preopercle length	18.5-20.1	19.3
Snout length	10.6-12.1	8.5
Inter orbital width	9.6-10.2	7.7
Orbital width	5.0-6.9	5.6
Head width	12.1-13.8	11.9
Gape width	7.2-9.1	5.1
Head depth at pupil	14.8-16.2	14.7
Head depth at occiput	19.2-22.3	19.5
Maxillary barbels	5.7-6.9	2.8
Rostral barbels	6.3-7.2	2.8
Dorsal fin height	19.9-24.4	18.3
Dorsal fin length	14.8-17.2	12.7
Pectoral fin length	16.5-18.4	17.5
Circumferential scales	34-35	34
Circumpeduncular scales	19.20	20
Lateral transverse scales	8/1/5	9/8
Scale rows between lateral line & pelvic fin	5	5
Scale rows between vent and anal fin	2	2

Colour: In life, greyish on the back, silvery below with a pinkish tinge, body black at scale margins, a black band just at the margin of opercle. Fins pinkish with dorsal fin grey and black tinge. Upper and lower lobes of caudal fin are red in colour.

Distribution: India: Manipur, Lokchao, Charickong and Maklang. Myanmar: Monywa, Sagaing and Irrawaddy drainage.

Remarks: The fish is found in warmer months, ie., April to September. In winter months, it does not occur in these rivers, probably migrating upstream for breeding. It is a migratory fish, most commonly found in the lower course of the river system.

The present specimens agree with the original description of the specimen from Monywa, upper Myanmar described by Myers (1924). There are slight differences in the morphometry, viz, snout length, interorbital wide, gape width, length of barbel, head width etc. of the present specimens and previous descriptions. However, these are small and are probably due to environmental factors. The variations fit within the range of *Chagunius nicholsi*. The standard length of Manipur specimens ranged from 108.2-206.9 mm. During the breeding season, the colour of the fins is brighter than in other seasons. The fish is easily identified trom other species because of its brightly coloured caudal fin. Three species of *chagunius* Smith are so far known, viz. *C. nicholsi* (Myers), *C. chagunio* (Ham.) and *C. baileyi* (Rainboth). *Chagunius baileyi* (Rainboth) is distributed in the Salween and Sittang drainages of Thailand and Myanmar. *Chagunius chagunio* (Ham.) is a species of the Ganga-Brahmaputra drainage of India. This paper extends the distribution of *Chagunius nicholsi* (Myers) from itsoriginal Irrawady drainage in Myanmar to the Chindwin headwaters in Manipur, India.

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MACROBENTHOS FROM THE MUDFLATS OF THANE CREEK, MAHARASHTRA, INDIA[1]

R.P. Athalye and K.S. Gokhale[2]

(*With five text-figures*)

Key words: Mangrove, *Avicennia marina,* Thane creek.

Thane creek, which extends 28 km northwards from Bombay Harbour joins the Ulhas River near Thane city. It has mangrove mudflats which are mainly tide dominated, but they receive large amounts of domestic and industrial effluents. This paper reports on the invertebrate fauna including polychaetes, gastropods, bivalves and sea anemones, collected over one year from the mudflats of the Thane creek upstream of Thane city.

Introduction

Thane Creek (19° to 19° 15' N lat. and 72° 55' to 73° 00' E long.) extends about 26 km northwards from the south of Bombay (Mumbai) Harbour Bay and joins Ulhas River by a minor connection near Thane city. The influence of riverine water is negligible in the creek (except during the rainy season) and it is mainly tide dominated. There are well-formed mangrove (*Avicennia marina*) mudflats all along the creek. Due to heavy urbanisation and industrialisation in this region, the creek receives large amounts of domestic and industrial effluents. The present study reports observations on polychaetes, gastropods, bivalves and sea anemones in the mudflats of the upstream part of Thane creek near Thane city.

Material and Methods

Monthly samples were collected for one year (1986-87) from two stations — one on the west bank and the other on the east bank, the latter being about 1000 m upstream from the earlier one (Fig. 1). At each station, ten samples of surface sediment (5 cm depth) were collected during low tide, using a metal shovel of 0.01 sq. m area. The samples were pooled and sieved (using creek water for washing) through a 0.5 mm sieve to separate the macrobenthic organisms, which were then fixed in 10% formalin in filtered creek water. The organisms were narcotised and extended prior to fixation.

Duplicate samples were used to determine the density (number) per sq. m. and biomass (wet wt.) per sq. m for each species.

Important water parameters were analysed by the methods recommended in "Standard Methods" (APHA, AWWA and WPCF, 1981) while sediment texture was assessed using Beaker method (Piper, 1947).

The polychaetes were identified by the authors using the key provided by Fauvel (1953), whereas the mollusc identification was done at the British Museum, London. Sea anemones were identified by Maj. K.W. England, University of Reading, U.K.

Results

The two study sites experienced more or less similar physico-chemical conditions. The ranges of different parameters were: temperature 22° to 34° C, pH 6 to 7.8, salinity 0.4 ppt (during monsoon) to 30 ppt (during summer) and dissolved oxygen 2.2 to 6.4 mg/1. The sediment was silt-clay with almost 65% clay and 22% silt. The sand percentage increased up to 15% only during the rainy season.

The macrobenthic community encountered in this region included polychaetes, gastropods, bivalves and sea anemones.

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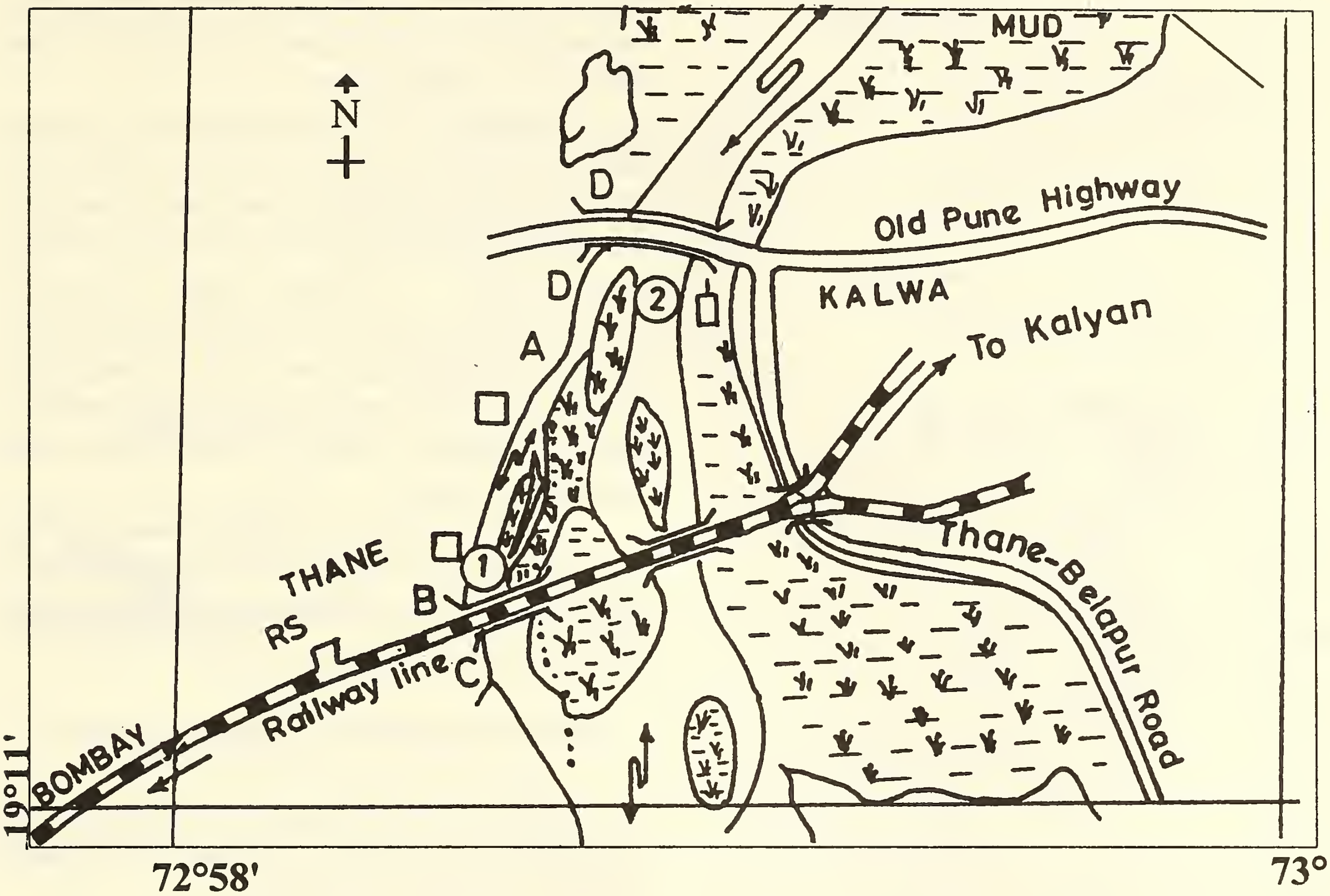


Fig. 1. Map of Thane creek showing study stations

ANNELIDA: POLYCHAETA

Four species of polychaetes were recorded. All belonged to the family Nereidae.

i) ***Lycastis indica*** (Southern) Fig. 2

The Genus *Lycastis* is characterised by uniramous feet and proboscis without paragnaths.

Lycastis indica has been reported from Chilka Lake (Southern, 1921) Indonesia (Siboga Expedition, Horst, 1924) and Madras (Fauvel, 1930). It has also been reported from Salt Lake (estuarine brackish waters near Calcutta; Miragamari Creek, Bengal; Marmugao Bay; Vishakhapatnam backwaters; Madras and Cochin backwaters near Ernakulum (Fauvel, 1953). The species is a fresh and brackish water organism.

The specimens obtained from Thane creek had a length of 30 to 50 mm, breadth 3 mm, red brown pigmentation at the base of tentacular cirri, eyes with lenses, outer pair of eyes bigger and placed a little forward than the inner, median groove on head ending in a pit and jaws with 9 teeth. Anal segment was conical with terminal slit, conspicuous streaks of reddish brown pigment and short anal cirri.

The first parapodial pair did not have dorsal setae, whereas the other parapodia had one, two or three setae in dorsal division. Ventral setae in all the parapodia had two groups in which heterogomph falcigerous setae were dominant. Parapodia of posterior segments had enormous dorsal cirri which, in some bigger specimens, were broad at the base, with leaflike appearance. In these parapodia, median ligule and ventral cirri were small and inconspicuous.

Density of *L. indica* was 100 to 3000 per sq. m (the highest being during monsoon) and average biomass (wet wt.) 40 g per sq. m.

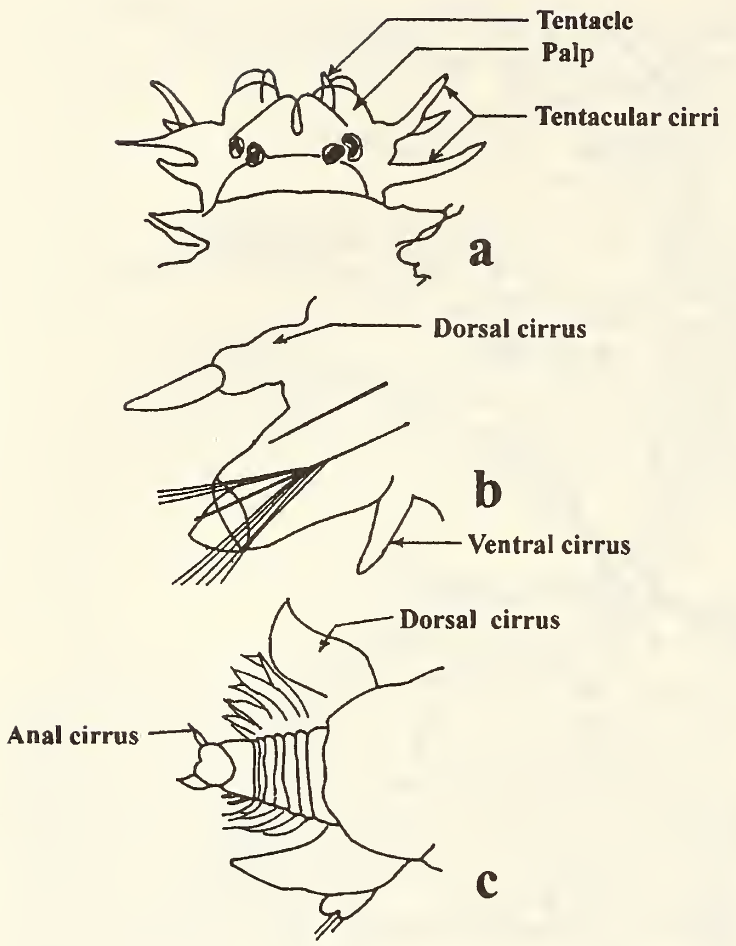


Fig. 2. a: Head; b: First foot; c: Posterior segments of *Lycastis indica*

ii) ***Lycastis ouanaryensis*** (Gravier) Fig. 3.

The species has been reported from French Guyana by Fauvel (1953). It occurs in marine as well as fresh water. According to Fauvel (1932), *Lycastis indica, L. ouanaryensis* and *L. meraukensis* might be varieties of the same species, and depending on the environmental difference, the characters such as position of eyes, number of teeth on the jaws, types of setae on parapodia etc. may show wide variation.

Compared to *L. indica,* the specimens of *L. ouanaryensis* were more slender (35 to 40 mm long and less than 0.5 mm broad). They also differed in having eyes without lenses, jaws with 6 teeth and the posterior parapodia with dorsal cirri very elongated (Fig. 3d). Other characters included head with distinct palps, small tentacles and a median groove extending upto the first pair of eyes; dorsal tentacular cirri long, reaching third thoracic segment; proboscis without paragnaths; anal segment button-shaped with long cirri and yellowish brown pigment.

Parapodia showed uniramous structure, characteristic of the genus *Lycastis.* The dorsal cirrus was slender, dorsal setae either missing or two hemigomph spinigerous setae were present. Two groups of ventral setae could be distinguished with hemigomph spinigerous, heterogomph spinigerous and heterogomph falcigerous setae commonly occurring. Posterior parapodia had few setae and dorsal setae were completely absent.

L. ouanaryensis had density ranging from 1,700 per sq. m (in summer) to 14,300 per sq. m (during post-monsoon) and the average biomass (wet wt.) was 25 g/ sq. m.

iii) ***Nereis glandicincta*** (Southern) Fig. 4.

Genus *Nereis* is characterised by biramous parapodia and proboscis with horny paragnaths arranged in distinct groups.

Nereis glandicincta has been found to occur in marine, fresh water or brackish ecosystems. It has been reported from Chilka Lake (Southern, 1921); ecosystems around Calcutta, salt lakes near Garia, Vishakhapatnam, Taleh-Sap and Gulf of Siam (Fauvel, 1932).

The specimens in the present study were of average length and breadth 30 to 60 mm and 2 to 3 mm respectively, the head is narrow on the anterior side and broad on the posterior side, short palps and prominent tentacles on head, a small notch on the head between the tentacles extending as a line up to the first pair of eyes, posterior dorsal tentacular cirri very long, two pairs of eyes with lenses, the pharynx with paragnaths as described by Southern (1921) and jaws with 15 to 16 teeth. According to Southern (loc. cit.), the number of teeth may vary, as he observed 10 teeth in the jaws of the specimens from the salt lake at Dhappa.

The anal segment was conical and had a terminal slit and anal cirri shorter than tentacular

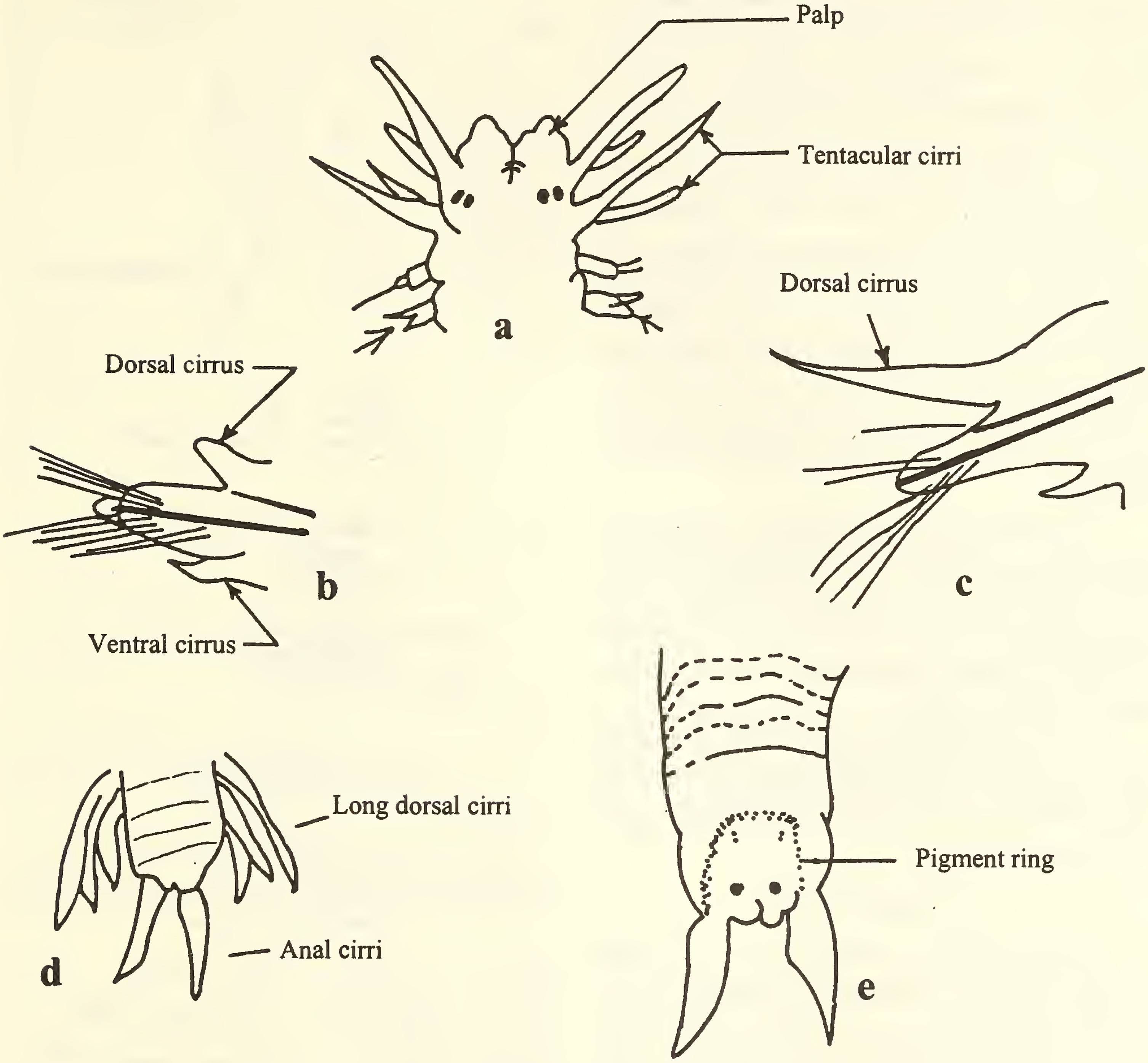

Palp
Tentacular cirri
a
Dorsal cirrus
Dorsal cirrus
b
Ventral cirrus
c
Long dorsal cirri
Anal cirri
d
Pigment ring
e

Fig. 3. a: Head; b: First foot; c: Posterior foot; d: Posterior segments; e: Anal segment of *Lycastis ouanaryensis*

cirri. A ring of reddish brown pigment was present round the middle of the segment.

The first parapodium had only one aciculum and the dorsal division of setae was absent. As described by Southern (loc. cit.), falcate setae were absent in the anterior and posterior parapodia and hemigomph falcates with curved tip (Fig. 4d) were observed on the 30th foot.

The most important feature of this species is the presence of glands at the base of dorsal and ventral cirri and girdle of glands around each segment, which was distinct.

Density of *N. glandicincta* was minimum in monsoon (50 per sq. m) and maximum post-monsoon (3600 per sq. m), whereas the average biomass (wet wt.) was 5 g. per sq. m.

iv) ***Dendronereides*** sp. (Southern) Fig. 5

Genus *Dendronereides* is characterised by the absence of dorsal division of setae in first and second feet, absence of ventral ligula in all parapodia, dorsal ligule in anterior feet branched, having 5 to 11 filament-like outgrowths (feet branchiae) in which blood vessels are absent, posterior parapodia with dorsal ligule simply elongated (Fig. 5e). All these characters described by Southern (loc. cit) were observed in the specimens of Thane creek. However, the characters of *D. heteropoda* viz. absence of heterogomph setae and presence of a peculiar gland at the base of dorsal cirrus (Southern 1921; Fauvel (1932) were not observed. Hence, the species could not be confirmed. *Dendronereides heteropoda* has been reported in the vicinity of Calcutta, Diamond Isles, Shat-el-Arab and Thane (Mumbai).

The specimens in the present investigation had an average length of 20 to 30 mm and breadth 2 mm, head with yellowish black pigment, tips of palps and cirri white, eyes with lenses, anterior pair of eyes smaller, proboscis with soft papillae and jaws with 27 teeth.

Dendronereides sp. had density ranging from 0 per sq. m. (in pre-monsoon) to 7020 per sq. m. (in monsoon) and average biomass (wet wt.) 5g per sq. m.

MOLLUSCA

Melvil (1893, 1896) first described the marine Mollusca of Bombay (=Mumbai), from the collection of Abercrombie during 1888-1892, in which littoral molluscs thrown ashore were considered. Preston (1915) also studied molluscs around Bombay (=Mumbai).

In the present investigation, 6 species of Mollusca were identified, courtesy of the British Museum, London, out of which 4 were gastropods and 2 bivalves. Three species remained unidentified.

GASTROPODA

1. ***Dostia violacea*** (Gmelin)

This species is known since 1822 by various names:

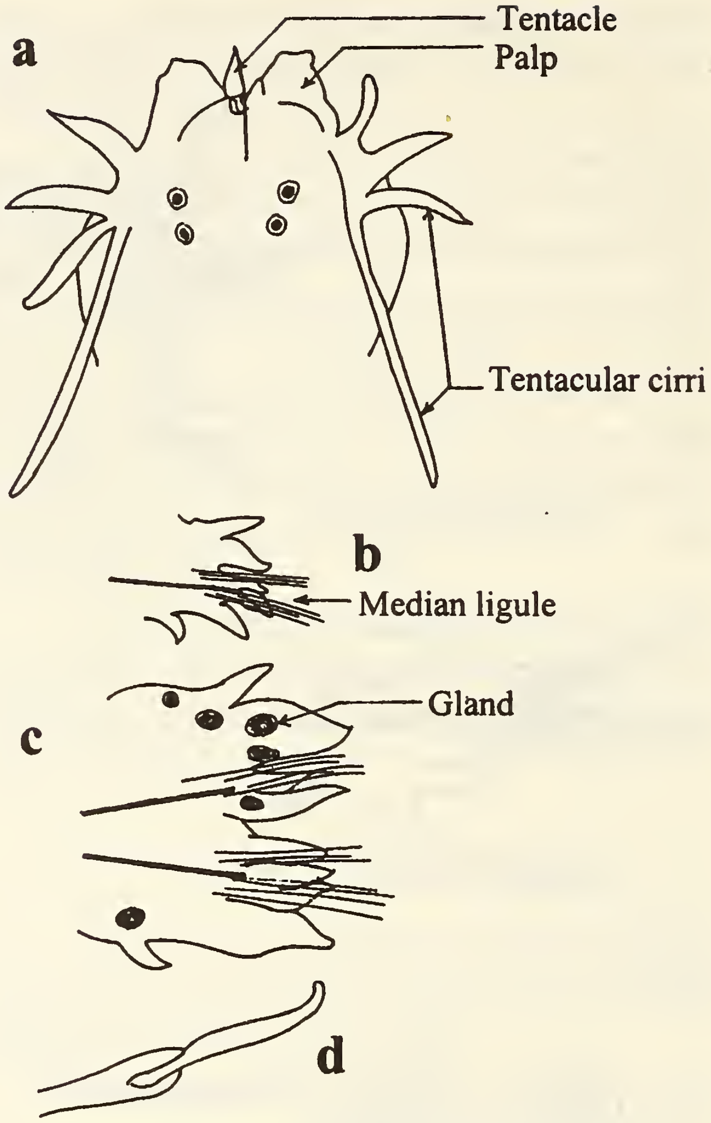
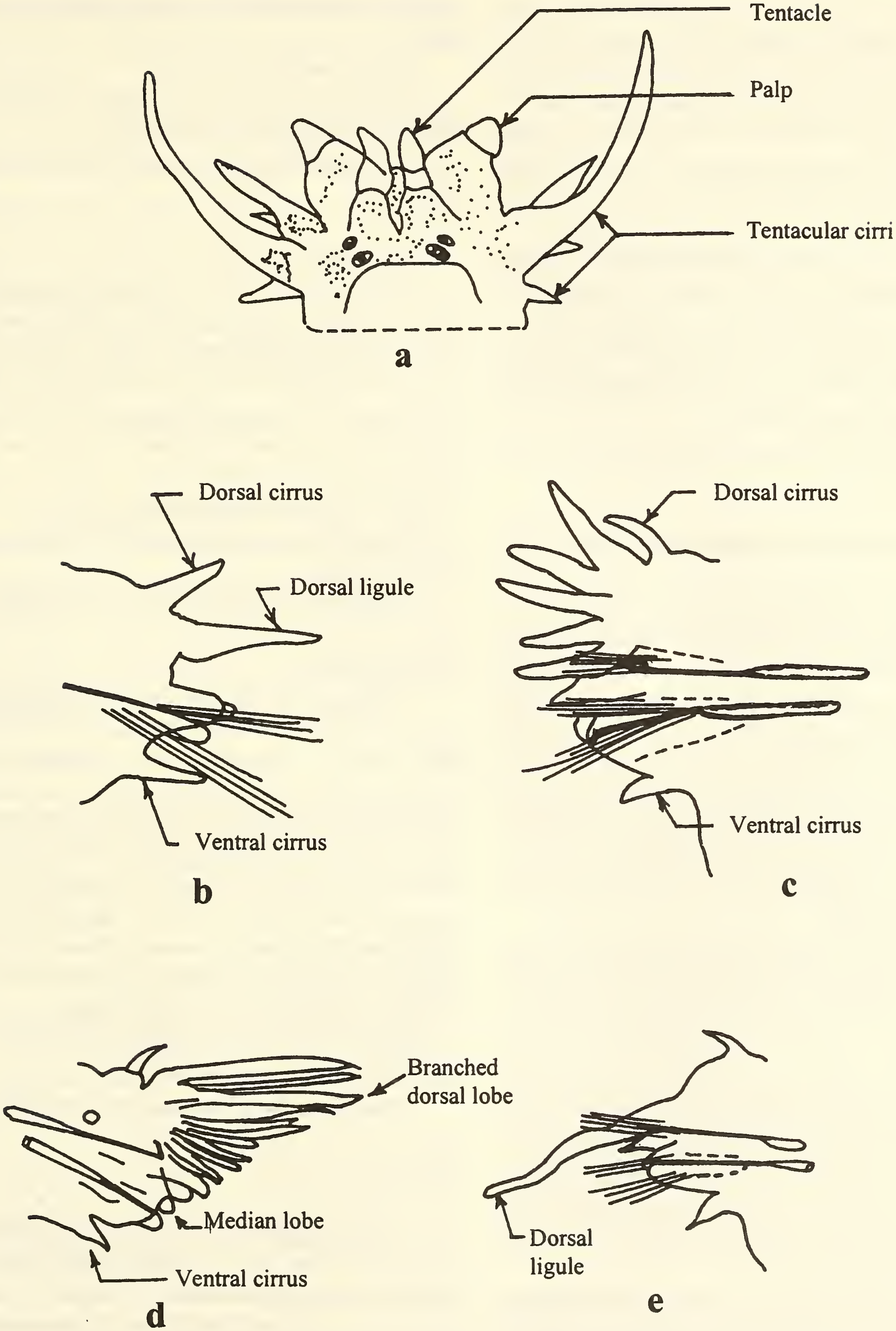


Fig. 4. a: Head; b: First foot; c: Tenth foot; d: Hemigomph falcigerous seta on thirtieth foot of *Nereis glandicincta.*

Neritina crepidularia, Lamark, 1822.
Neritina crepidularia, Van Mortens, 1897.
Neritina (Dostia) crepidularia, Prasad, 1921.
Neritina violacea Van benthem Jutting, 1956.
Neritina violacea, Gmelin, 1971.

Prasad (1921) described *Dostia* as a subgenus of *Neritina* and has reported *D. crepidularia* in the freshwaters of lower Mesopotamia. Annandale and Prasad (1919) reported it from the Gangetic delta. *D. violacea* has been reported in many estuarine and coastal areas in India such as Mahanadi estuary, Orissa, Gangetic delta, Godavari and Krishna estuaries, backwaters of Cochin and Marmugao Bay in Goa. It has a wide distribution extending to Myanmar, Malaya, Bali and Timor, the Philippines, southern


Tentacle
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a
Dorsal cirrus
Dorsal ligule
Ventral cirrus
b
Dorsal cirrus
Ventral cirrus
c
Branched dorsal lobe
Median lobe
Ventral cirrus
d
Dorsal ligule
e

Fig. 5. a: Head; b: First foot; c: Tenth foot; d: Twentieth foot; e: Thirtieth foot of *Dendronereides* sp.

Japan and New Caledonia (Subba Rao and MookherjeeMedian ligule 1975). According to Govindan and Natarajan (1972) who studied *Dostia crepidularia* in Coleroon estuary, this marine species is well adapted to freshwater. They described the females as bigger (22 x 15 x 11 mm) than males and breeding from March to November with peak activity in June, July and August.

In the present study, this gastropod was more common at sewage polluted sites and was noticed grazing on the algal growth on rocks and mud.

Size: Length 9 to 20 mm, breadth 7 to 13 mm.

Density: 50 per sq. m (post-monsoon) to 450/sq. m (late post-monsoon).

Average Biomass (shell-free wet wt.): 30 g/sq. m.

2. ***Cerithideopsilla djadjaviensis*** (Martin)

Genus *Cerithideopsilla* is essentially a brackish water form. Subba Rao and Mookherjee (loc. cit.) have reported it in brackish and saltwater ponds near Khira Gachha Madeli, Mahanadi estuary. It is a widely distributed genus and is common in all the estuaries and backwaters of India, Myanmar, Singapore and Hongkong. It occurs widely in the Indian Ocean and Western Pacific (Subba Rao and Mookherji, loc. cit). In Java, it is a serious pest in freshwater ponds (Schuster, 1949).

Though *Cerithideopsilla djadjaviensis* has not been reported from India, other species of this genus have been described by many workers. The most widely reported species is *Cerithideopsilla cingulata* from estuarine mudflats of Krishna River (Rao and Sukumar, 1982) and mangrove swamps (Price *et al.* 1987). Hornell (1951) has reported *Potamides cingulata* and other species of families Certhididae and Cerithideopsidae in Mumbai waters, but did not record this species.

Cerithideopsilla burrows in soft sediment (Rao and Sukumar, loc. cit.) as it is sensitive to desiccation (Yipp, 1982). For this reason, *C. djadjaviensis* was never found at sites where mud-flats were polluted by sewage and therefore anoxic.

Size: Length 6 to 20 mm.

Density: minimum 300/sq. m (pre-monsoon) to 600/sq. m (monsoon).

Average Biomass (shell free wet wt.): 25 g/sq. m.

3. ***Paludomus*** sp.

Many species of *Paludomus* are commonly found in fresh water (Annandale 1918; Preston, 1915; Tonapi and Mulherkar, 1963). *Paludomus obessa* (Philippi) has been reported in the freshwaters of Bombay (=Mumbai) by Preston (1915). The present specimens could not be identified upto the species level.

Size: Length 4 mm, breadth 3 mm.

Density: 00/sq. m (monsoon) to 10000/sq. m (post-monsoon).

Biomass (shell-free wet wt.): negligible.

4. ***Stenothyra*** sp.

This genus is characterised by a small shell, rarely exceeding 5 mm in length, but relatively thick, ovate or subcylindrical. Annandale and Prasad (1919, 1921) described the subfamily Stenothyrinae as estuarine (Gangetic delta) and gave a key for identification of this genus. *Stenothyra minima* (=*Namatura minima*) was reported from Rann of Kutch, Saurashtra, Sri Lanka and Chilka lake. *S. minima* (Sowerby) was reported in Bombay waters by Hornell (1951).

Size: Length 4 mm, breadth 3 mm.

Density: 00/sq. m (post-monsoon) to 2000/sq. m (late post monsoon)

Biomass (shell-free wet wt.): negligible.

BIVALVES

Five species of bivalves were collected throughout the year, of which only two viz. *Sphenia sowerbyi* (Smith), (length 15 mm, breadth 9 mm and thickness 5.5 mm) and *Laternula navicula* (length 7 mm, breadth 4 mm thickness 3 mm) were identified. These may probably be reported for the first time from India. Both bivalves occurred in small numbers.

Hanks and Packer (1985) have described *Sphenia sincera* in the subtidal region of Gulf of Maine. It was found to prefer soft silt-clay sediment and formed the major food item for bottom feeding fish. Hornell (loc. cit.) reported *Laternula labiata* in Bombay (=Mumbai) waters.

The other three bivalves, which were very small in size, could not be identified.

COELENTERATA

SEA-ANEMONES

Two new species of burrowing sea anemones were obtained. They were absent from the sewage polluted mud-flats, probably due to anoxic conditions. The sea anemones occurred during December to June, when salinity was more than 20 ppt. England (1989) has published detailed descriptions of the two species given below.

1. ***Edwardsia athalyei*** England

This species is different from *E. tintrix* reported by Parulekar (1968).

Description: Size of largest specimen: 13 mm high and 3 mm in diameter. Tentacles slender, tapered, conical, numbering upto 16.

2. ***Acontiactis*** England.

Acontiactis gokhaleae England.

Genus *Acontiactis* differs from *Acontiophorum* in having more mesenteries distally than proximally, and 5 pairs of macronemes or less, compared with 12 pairs in *Acontiophorum*. *Acontiophorum bombayensis* has been described by Parulekar (loc. cit).

Description: Maximum height 10 mm, column diameter 4 mm (contracted). Tentacles short, tapered, hexamerously arranged, numbering upto 48 or more, a definite base present.

The sea anemone *Acontiactis gokhaleae* was more common. Highest density (400/sq. m) was recorded in pre-monsoon and average biomass (wet wt.) was 3 g/sq. m.

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TWELVE NEW SPECIES OF GENUS *PACHYPROTASIS* HARTIG (HYMENOPTERA, TENTHREDINIDAE: TENTHREDININAE) FROM INDIA[1]

[2]MALKIAT S. SAINI AND V. VASU

(*With fifty-eight text-figures*)

Key words: New species, *Pachyprotasis* Hartig, new synonymy, revised key, Hymenoptera, India.

Twelve species new to the genus *Pachyprotasis* Hartig are added to Indian fauna. Described and illustrated as new are: *P. maculiventris, P. kulwantae, P. cephalopunctata P. politus, P. cuneativentris, P. nigricans, P. salebrousa, P. hargurmeeti, P. foveatus, P. pleuricingulata, P. punamae* and *P. frontatus*. Seven subspecies viz. *P. birmanica tristis* Malaise, *P. birmanica eburnipes* Malaise, *P. opacifrons subpunctata* Malaise, *P. albicincta nigripleuris* Malaise, *P. albicincta albitarsis* Malaise, *P. albicincta sinobrimanica* Malaise and *P. caerulescens kashmirica* Malaise have been merged into their respective species. A key for identification of all the Indian species is provided.

INTRODUCTION

After Malaise's (1945) revisionary work on Tenthredinoidea of southeast Asia, Saini and Kalia (1989) attempted to update Indian fauna of the genus *Pachyprotasis* Hartig by recording 9 species for the first time from this region and describing 9 species as new to science. The major contributors to Indian fauna of this genus are: Malaise (1934, 1945) with 9 species and 2 subspecies, Singh *et al.* (1987) with 4 species, Forsius (1933) with 4 species, Cameron (1876, 1881, 1889, 1902) with 4 species, Saini and Kalia (1989) with 9 species, Rohwer (1916) and Linnaeus (1767) each with one species. Seven subspecies have been merged into their respective species. Since the name *P. malaisei* Singh *et al.* was preoccupied, Saini and Vasu (1995) renamed it as *P. punctulatis*. In the present text twelve species have been illustrated and described. A workable key for identification of all Indian species is provided. Type materials of new species are housed at Division of Entomology, Pusa National Collection, Indian Agricultural Research Institute, New Delhi. Abbreviations used in text are: EL = eye length; IATS = inner apical tibial spur; ICD = inter cenchri distance; IDMO = interocular distance at level of median ocellus; ITD = inter tegular distance; LID = lower interocular distance; MB = metabasitarsus; OATS = outer apical tibial spur; OCL = oculo-occipital line; OOL = oculo-ocellar line; POL = postocellar line.

KEY TO INDIAN SPECIES OF *PACHYPROTASIS* HARTIG

1. Antenna ringed (two or three middle joints of different colour than apical and basal joints). 2
- Antenna not ringed 6
2. Head almost impunctate 3
- Head with large, distinct punctures and surface between them microsculptured .... *sikkimensis* Saini & Kalia
3. Antennal segment 3 shorter than 4 4
- Antennal segment 3 longer than 4 .... *birmanica* Forsius
birmanica tristis Malaise syn. nov.
birmanica eburnipes Malaise syn. nov.
4. Supraantennal tubercles insignificant or low. 5
- Supraantennal tubercles raised, quite prominent and abruptly cut off from frontal ridges .... *versicolor* Cameron

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5. All coxae sanguineous, almost without black (in male pro- and mesocoxae straminous, without black); antennal joints 6 and 7 white; postocellar furrow wanting; stigma fulvous .... *multilineata elineata* Malaise

- All legs pale with black markings, without reddish; antennal joints 5 and 6 yellowish; postocellar furrow present; stigma black with pale anterior margin .... *alboannulata* Forsius

6. Antenna unicoloured or with narrow pale stripe along underside 7

- Apical 3 antennal joints black, rest reddish .... *indica* (Forsius)

7. Antenna black 8

- Antenna fulvous .. *kalatopensis* Saini & Kalia

8. Abdomen with reddish spots 9

- Abdomen without reddish spots 10

9. Abdomen reddish brown except central longitudinal streak on tergite 2, infuscated lateral spots more prominent on tergites 3 - 6 .... *indica* (Forsius)

- Abdomen mainly black, tergites 2-5 with large, medial triangular spots, all medially connected to each other .... *maculiventris* sp.nov.

10. Body except legs pale with few black markings 11

- Body except legs black with some whitish or pale markings 13

11. Postocellar area distinctly wider than long 12

- Postocellar area as long as broad .... *vittata* Forsius

12. Appendage carinate; head and mesonotum micropunctured with minute and dense punctures; supraantennal pit distinct; antennal segments 3 and 4 as 4:5; inter- and postocellar furrows absent; area posterior to eye pale entirely; pronotum entirely pale; abdomen almost pale .... *pallens* Malaise

- Appendage not carinate; head and mesonotum impunctate; supraantennal pit indistinct; antennal segments 3 and 4 as 4:3; inter- and postocellar furrows present; black spot posterior to eyes; narrow upper margins of pronotum black; black lining along anterior border of tergites 1-6 .... *lachenensis* Saini & Kalia

13. Hind legs reddish with few black or pale yellow markings 14

- Hind legs black or pale yellow without reddish 25

14. Antennal segment 3 longer than or subequal to 4 15

- Antennal segment 3 distinctly shorter than 4 .... *manaliensis* Singh *et al.*

15. Mesoscutellum pyramidal (Fig.44) 16

- Mesoscutellum flat (Fig.46) 18

16. Body black with pale lower 1/2 of frontal area; pale orbit around eyes except spot on upper corner of each eye black; pronotum pale except its black posterior margin; pale lateral margins of mesonotal middle lobe meeting at apex; basal 2/3 of metafemur reddish, apical 1/3 pale; postocellar area convex, with median longitudinal furrow; head with few insignificant, scattered punctures .... *subtilissima* Malaise

- Body black with frontal area entirely black; whitish yellow lower 1/2 of inner orbit continued with lower 1/4 of hind orbit; pronotum entirely black; sagittated apex of mesonotal middle lobe pale; basal 1/2 of meta femur pale, apical 1/2 reddish; postocellar area flat, without medial longitudinal furrow; head with dense, minute punctures 17

17. Supraantennal tubercles distinctly raised; median fovea ditch-like in its anterior 1/2 and posteriorly shallowly reaching median ocellus; mesosternum yellowish in both sexes .... *kulwantae* sp.nov.

- Supraantennal tubercles just indicated; median fovea shallow in its anterior 1/2 and posteriorly not reaching median ocellus; mesosternum black in female only .... *subtilis* Malaise

18. Hind legs reddish or fulvous without pale, with black markings 19

- Hind legs reddish with black as well as pale markings 20

19. Body black, yellowish white are: labrum, lateral spots on clypeus, supraclypeal area, 2 dots above bases of antennae, lower 2/3 of hind orbit, inner orbit narrowly connected with elongated temple spot, spot on posterolateral margin of pronotum, anterior half of tegula, small spot on anterolateral margin of mesonotal middle lobe, longitudinal middle band on mesoscutellum, appendage, metascutellum, posterolateral margin of mesepimeron, irregular small spot on anterior slope of mesepisternum, 3/4 of metapleura posteriorly, lateral elongated spot not meeting on anterior margin of tergite

2, triangular medial spot on hind margin of tergite 5, tergite 9 entirely, broad hind margin of deflexed sides of all tergites and of all sternites; clypeus roundly incised with somewhat truncate basis, median fovea in form of pit in middle of frontal area .... *maesta* Malaise

- Body black, yellowish are: labrum except large medial spot, temple, narrow hind and lateral margins of deflexed sides of all tergites; clypeus subsquarely incised, median fovea indicated by shallow groove in its anterior half .... *mandalensis* Saini & Kalia

20. Antennal segment 3 distinctly longer than 4; supraantennal pit and median fovea absent ... . *citrinipictus* Malaise

- Antennal segments 3 and 4 subequal; supraantennal pit present; median fovea distinct or shallow 21

21. Head impunctate; clypeus rectangularly incised .... *punctulatis* Saini & Vasu

- Head punctate; clypeus roundly incised 22

22. Head strongly punctured 23

- Head not strongly punctured .... *cephalopunctata* sp.nov.

23. Punctures of mesonotum and mesoscutellum dense and confluent; mesopleuron rugose; frontal area at level of eyes; supraantennal tubercles low .... *ramgarhensis* Saini & Kalia

- Mesonotum, mesoscutellum and mesopleuron with minute, even and isolated punctures; frontal area below level of eyes; supraantennal tubercles raised 24

24. Body black, pale markings are: large temple spot narrowly connected with complete inner orbit, posterolateral margin of pronotum, spot before mesoscutellum, extreme posterior margin of mesepimeron, spot on anterior slope of mesepisternum, hind margins of all sternites; metafemur reddish except black apex; stigma black; supraantennal pit shallow; postocellar area subconvex with longitudinal middle furrow; median fovea shallow .... *subulicornis* Malaise

- Body black with above said pale markings missing, instead other pale markings which are absent in previous species here are present: a spot on tegula, sagittated apex of mesonotal middle lobe, stripe along pleurosternal suture, lower 1/3 of mesopleuron continuous with entirely fulvous mesosternum; hind margin of sternite 7; basal 1/3 of metafemur yellowish, rest is reddish; stigma dark brown with pale anterior half; supraantennal pit deep and punctiform; postocellar area convex, without longitudinal middle furrow; median fovea deep .... *flavipes* (Cameron)

25. Antennal segment 3 equal to or longer than 4 26

- Antennal segment 3 subequal to or shorter than 4 38

26. Forewings clear 27

- Forewings distinctly infuscated towards apex without sharp limits .... *parapeniata* Singh *et al.*

27. Supraantennal tubercles distinctly raised .. 28

- Supraantennal tubercles insignificant 29

28. Mesoscutellar appendage carinate; postocellar area without longitudinal middle furrow, twice as wide as long; head opaque owing to large, isolated punctures and surface between them micropunctured; mesonotum with distinct and dense punctures, mesopleura with large, isolated punctures on anterior slope; median fovea absent; labrum with rounded anterior margin; apical tooth of claw longer than subapical one.................... *opacifrons* Malaise

opacifrons alpestris Malaise syn.nov.

opacifrons subpunctata Malaise syn. nov.

- Mesoscutellar appendage ecarinate; postocellar area with longitudinal middle furrow, broader than long as 5:2; head shining with minute, scattered punctures; mesonotum with minute, isolated punctures; mesopleura almost impunctate; median fovea depressed, ditch-like; labrum with roundly pointed anterior margin; apical tooth of claw equal to subapical one ... . *icari* Saini & Kalia

29. Stigma pale (mesoscutellum roundly raised with hind apex somewhat incised; frontal area below level of eyes; mesopleura with indistinct, shallow punctures; median fovea absent; apical tooth of claw subequal to subapical one) .... *subcoreaceous* Malaise

- Stigma dark brown to black 30

30. Punctures on mesopleura minute, shallow and isolated 31

- Punctures on mesopleura large, distinct and confluent 32

31. Yellowish are: broad posterior margin of propodeum and posterior margin of tergites 2-6; POL:OOL:OCL = 2:3:3; postocellar area broader than long as 3:2 .... *politus* sp.nov.

- Yellowish are: extreme posterior angle of propodeum and tergites 2-7 with triangular medial spots; POL:OOL:OCL = 4:5:5; postocellar area broader than long as 5:4; .... *cuneativentris* sp.nov.

32. Mesonotum, mesoscutellum, appendage and abdomen entirely black ...... *nigricans* sp.nov.

- Mesonotum, mesoscutellum, appendage and abdomen with some yellowish markings ... 33

33. Mesoscutellum flat; frontal area at level of eyes; apical tooth of tarsal claw distinctly longer than subapical one 34

- Mesocutellum subconvex; frontal area below level of eyes; apical tooth of tarsal claw equal to subapical one 37

34. Head subrugose with dense, minute, shallow punctures; abdomen black above .... *salebrousa* sp.nov.

- Head smooth with few, scattered, irregular, distinct punctures; abdomen not entirely black above 35

35. Mesonotal middle lobe entirely black .... *hargurmeeti* sp.nov.

- Mesonotal middle lobe with pale markings 36

36. Pale lateral sides of mesonotal middle lobe meeting at apex; median fovea shallow in its anterior half and evenly depressed in its posterior half in form of horse-shoe with raised frontal sides .... *foveatus* sp.nov.

- Pale lateral sides of mesonotal middle lobe not meeting at apex; median fovea shallowly indicated in its anterior half only .... *albicincta* Cameron

albicincta nigripleuris Malaise syn.nov.
albicincta sinobirmanica Malaise syn.nov.
albicincta albitarsis Malaise syn. nov.

37. Broad anterior aspect of mesopleura yellowish white and extends as a transverse band in its lower 1/2 upto coxal rim, circumocellar furrow shallow, postocellar area broader than long as 5:4 .... *pleuricingulata* sp.nov.

- Broad anterior aspect of mesopleura yellowish white only, circumocellar furrow indistinct, postocellar area broader than long as 3:2 .... *punamae* sp.nov.

38. Mesocutellum flat (Fig.46) 39

- Mesoscutellum raised (Fig. 45) 42

39. Mesopleura subrugose; apical tooth of claw shorter than subapical one (median fovea reaching median ocellus) ..... *brunetti* Rohwer

- Mesopleura not subrugose; apical tooth of claw at least as long as subapical one 40

40. Median fovea reaching median ocellus; apical tooth of claw as long as subapical one ....*frontatus* sp.nov.

- Median fovea not reaching median ocellus; apical tooth of claw longer than subapical one 41

41. Supraantennal tubercles low, supraantennal pit deep, median fovea obsolete .... *longomalari* Singh et al.

- Supraantennal tubercles raised, supraantennal pit obscure, median fovea grooved and not reaching median ocellus .... *bengalensis* Saini & Kalia

42. Postocellar area without median longitudinal furrow 43

- Postocellar area with median longitudinal furrow .... *rapae* (Linneaus)

43. Head punctured and surface between punctures microsculptured 44

- Head with scattered punctures and without microsculpture 45

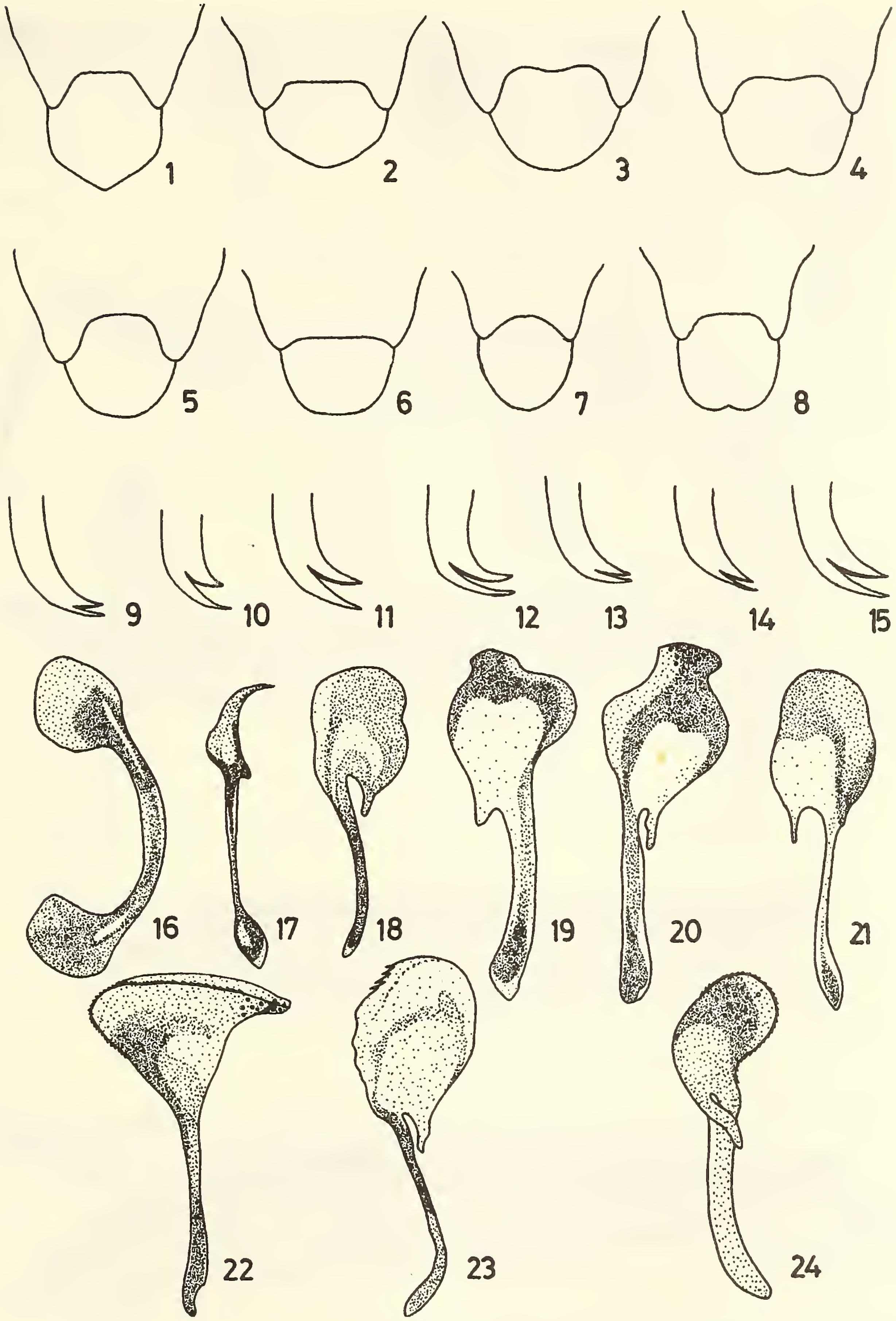
44. Malar space 1x diameter of median ocellus, circum- and interocellar furrows present, postocellar furrow absent, mesoscutellum strongly elevated with extreme apex mostly divided by furrow .... *caerulescens* Malaise

caerulescens kashmirica Malaise syn. nov.

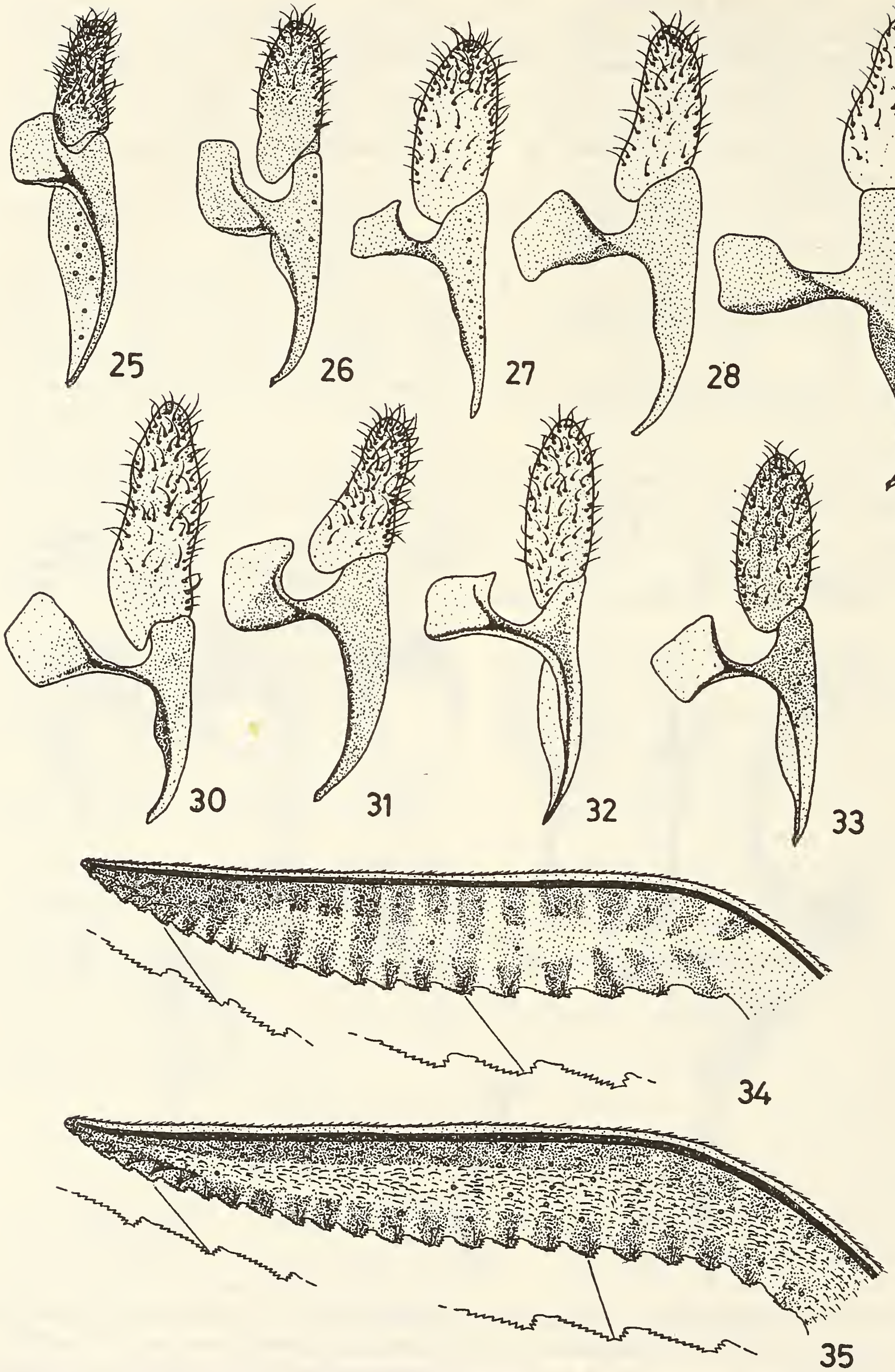
- Malar space 2x diameter of median ocellus, circum- and interocellar furrows absent, postocellar furrow present, mesoscutellum subconvex. .... *P. muelleri* Saini & Kalia

45. Frontal area black entirely; lower half or more of hind and inner orbits pale, sometimes inner orbit narrowly connected with pale temple spot; apex of mesonotal middle lobe pale; all tergites black above. Legs pale, black are: four front tibiae and tarsi posteriorly; apex of metafemur above and metatibia and tarsi entirely; postocellar area flat .... *violaceidorsata* Cameron

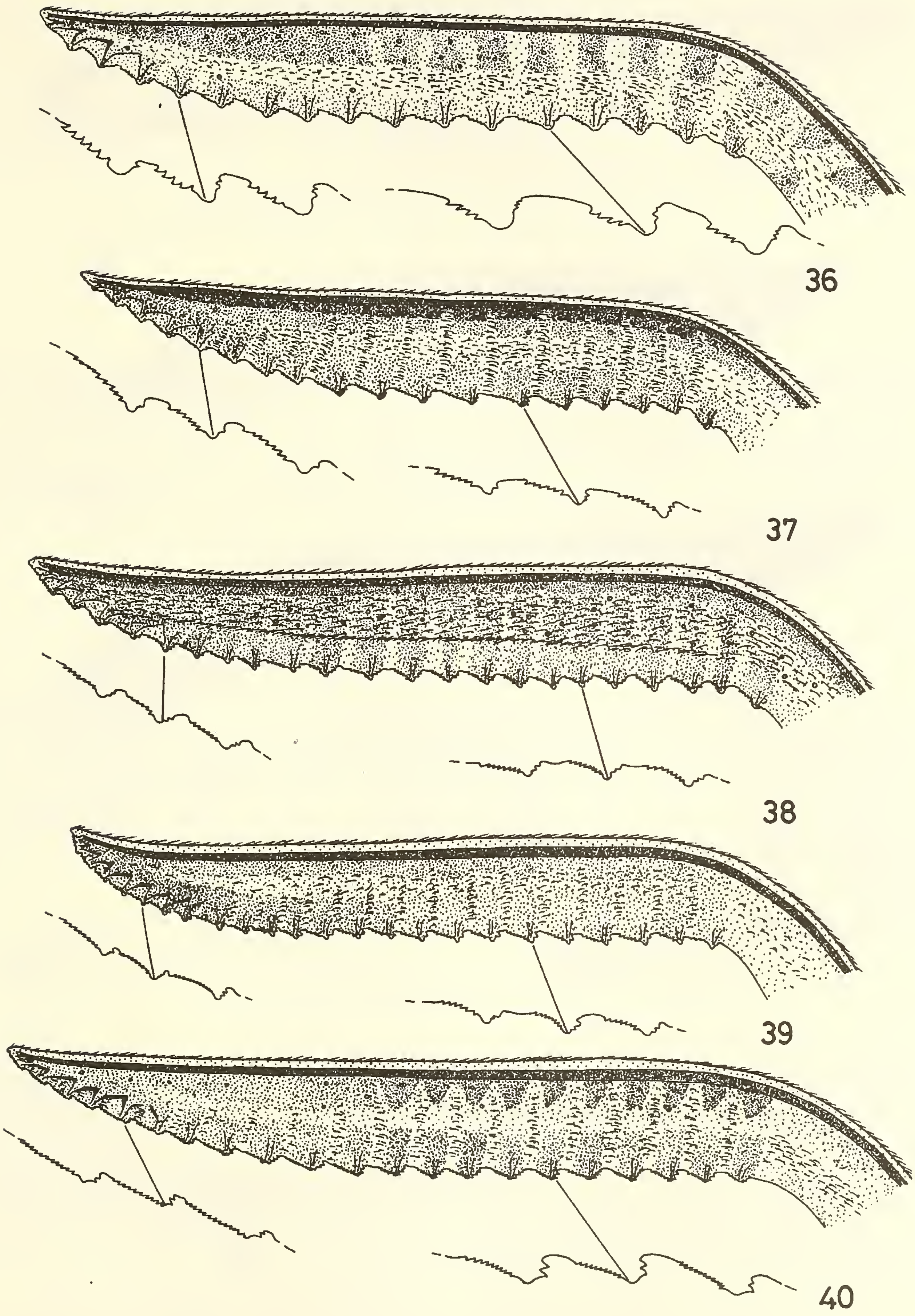
- Frontal area with large pale spot above antennae; broad hind orbit around eyes pale except area posterior to eyes; lateral corner of



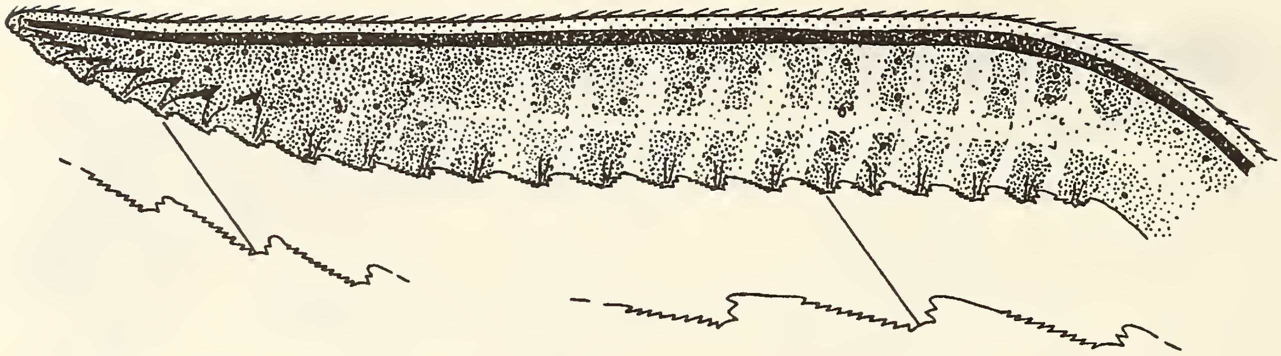
Figs.(1-24) Clypeus & labrum: 1. *Pachyprotasis maculiventris*, 2. *P. kulwantae*, 3. *P. nigricans*, 4. *P. pleuricingulata*, 5. *P. punamae*, 6. *P. frontatus*, 7. *P. cephalopunctata*, 8. *P. politus*;
Tarsal claw: 9. *P. maculiventris*, 10. *P. kulwantae*, 11. *P. nigricans*, 12. *P. punamae*, 13. *P. frontatus*, 14. *P. foveatus*, 15. *P. salebrousa*;
Penis valve: 16. *P. maculiventris*, 17. *P. kulwantae*, 18. *P. salebrousa*, 19. *P. hargurmeeti*, 20. *P. pleuricingulata*, 21. *P. frontatus*, 22. *P. foveatus*, 23. *P. politus*, 24. *P cuneativentris*.



Figs. (25-35) Gonoforceps: 25. *Pachyprotasis maculiventris*, 26. *P. kulwantae*, 27. *P. salebrousa*, 28. *P. hargurmeeti*, 29. *P. pleuricingulata*, 30. *P. frontatus*, 31. *P. foveatus*, 32. *P. politus*, 33. *P. cuneativentris*; Lancet: 34. *P. kulwantae*, 35. *P. cephalopunctata.*



Figs. (36-40) Lancet: 36. *Pachyprotasis nigricans*, 37. *P. salebrousa*, 38. *P. hargurmeeti*, 39. *P. foveatus*, 40. *P. pleuricingulata*.



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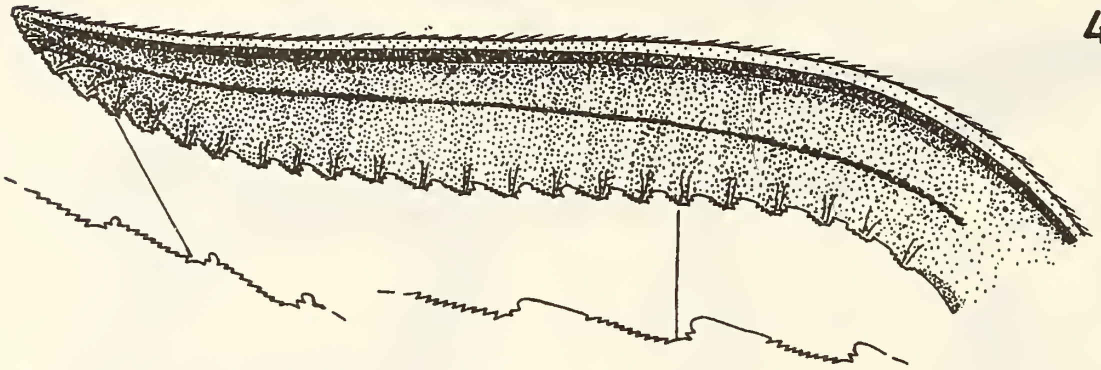

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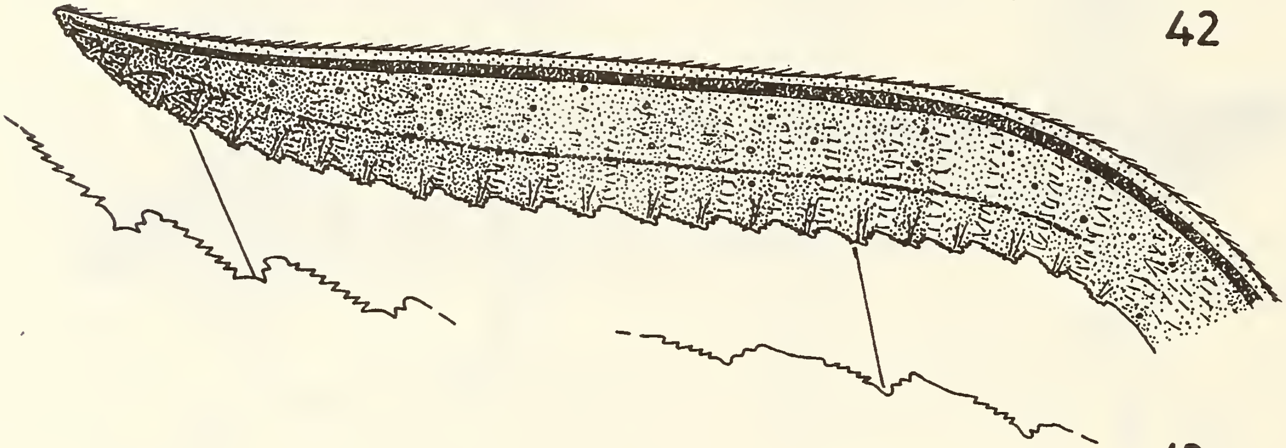

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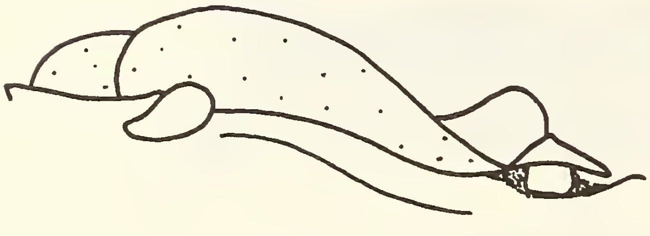

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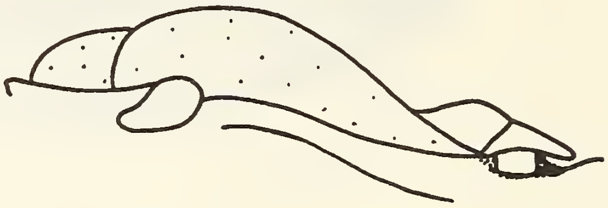

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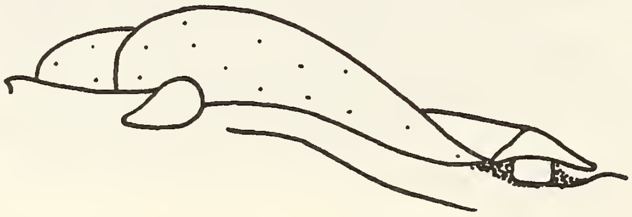

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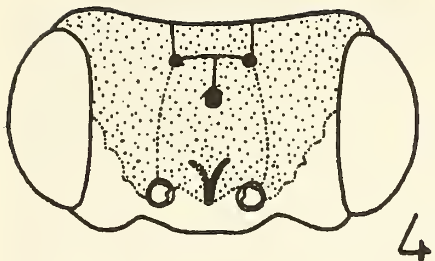
Figs. (41-46) Lancet: 41. *Pachyprotasis punamae*, 42. *P. politus*, 43. *P. cuneativentris*; Lateral view of Thorax: 44. *Pachyprotasis kulwantae*, 45. *P. cuneativentris*, 46. *P. cephalopunctata*.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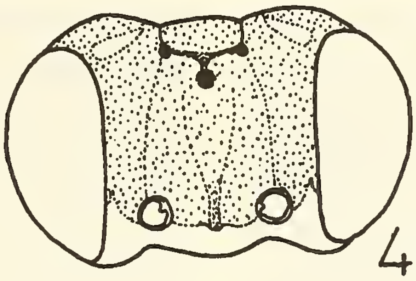
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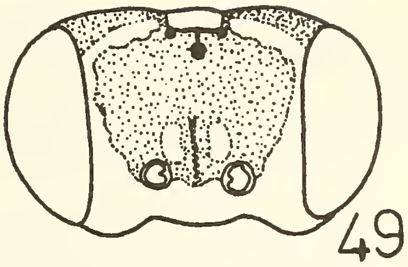
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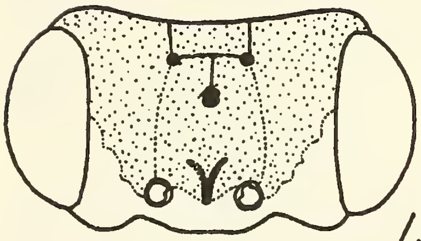
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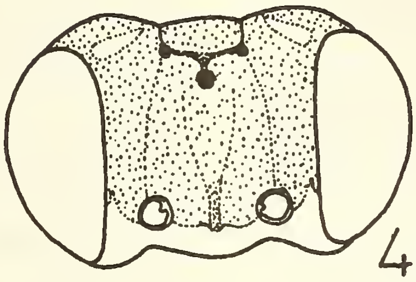
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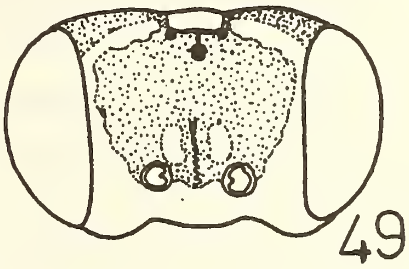
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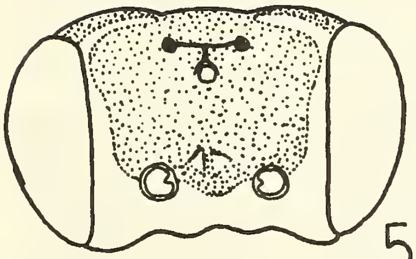
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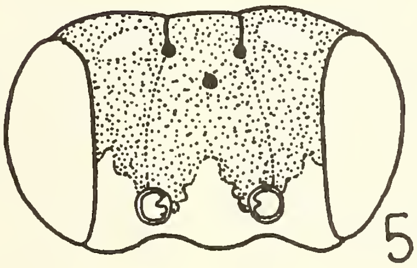
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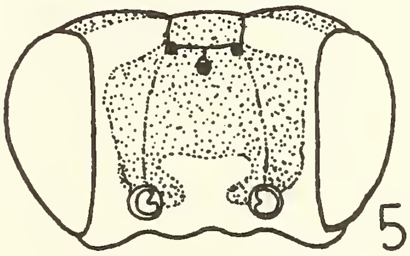
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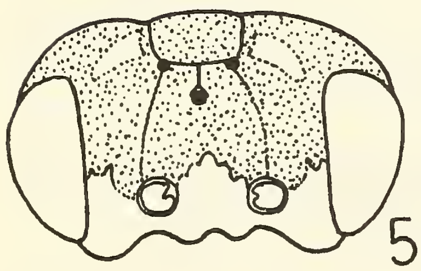
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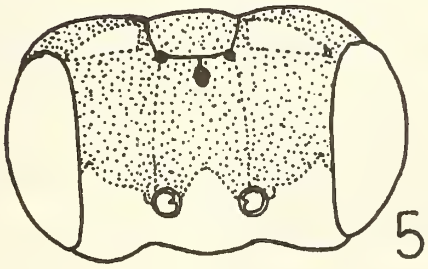
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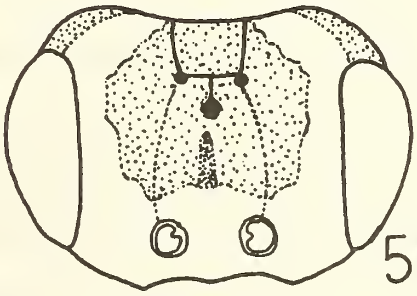
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Figs. (47-58) Colour pattern of Head: 47. *Pachyprotasis maculiventris*, 48. *P. kulwantae*, 49. *P. cephalopunctata*, 50. *P. politus*, 51. *P. cuneativentris*, 52. *P. nigricans*, 53. *P. salebrousa*, 54. *P. hargurmeeti*, 55. *P. foveatus*, 56. *P. pleuricingulata*, 57. *P. punamae*, 58. *P. frontatus*.

mesonotal middle lobe reaching apex pale; tergites black above with pale are: irregular lateral spots along posterior border of propodeum, posterior border in middle of tergites 2-6, tergite 9 entirely. Legs pale, black are: outer stripe from base of femur to apex of claw joint in front four legs, spot on metacoxa, outer and inner stripe on apical half of metafemur, rest of metaleg except narrow anterior stripe on tibia; postocellar area convex .... *manganensis* Saini & Kalia

Pachyprotasis maculiventris sp.nov. (Figs. 1,9,16,25,47)

Male: Colour: Body black, yellowish white are: underside of scape, clypeus except a basal medial stripe, labrum, mandible, a spot on supraclypeal area extending beyond base of antennae, broad inner and hind orbits except upper 1/4 (Fig. 47); broad posterolateral and streak-like posterodorsal margin of pronotum, tegula except extreme apex, anterolateral oval spot on mesonotal middle lobe, a spot on mesoscutellum, a transverse stripe on lower half of mesepisternum extending to anterior border, posterior border of mesepimeron; metasternum; anterolateral and lateral parts of all tergites sternites entirely; front four legs except outer stripe on femora, tibiae and tarsi, apical 1/2 of metacoxa, metatrochanter entirely, extreme base and dorsal stripe on metafemur, metatarsi 2-4 and adjoining part of metabasitarsus and of tarsal joint 5. Fuscoferruginous are: broad triangular spot on tergites 2-5, outer side of metafemur, metatibia except apical 1/5. Wings hyaline, venation including costa, subcosta and stigma dark brown.

Structure: Average length 6.5mm. Antenna 3.4x head width, segments 3 and 4 as 6:5; clypeus (Fig.1) subsquarely incised upto 1/3 of its medial length, labrum broader than long as 4:3 with roundly pointed anterior margin, malar space 2x diameter of median ocellus; LID:IDMO:EL = 7:6:5, OOL:POL:OCL = 3:2:2; frontal area below level of eyes; supraantennal tubercles moderately raised and confluent with low lying frontal ridges, supraantennal pit prominent, median fovea deep in its anterior 1/2 and posteriorly only shallowly reaching median ocellus; post- and interocellar furrows just indicated, circumocellar furrow indistinct, lateral furrows indicated and ending well before hypothetical hind margin of head; postocellar area subconvex, broader than long as 2:1; mesoscutellum convex, with a medial longitudinal carina on its posterior slope, appendage carinate, ICD:ITD = 1:4; metafemur longer than tibia as 7:6, metabasitarsus longer than following 3 joints combined as 8:7, IATS:MB:OATS = 3:4:2, apical tooth of claw subequal to subapical one (Fig.9). Genitalia: Penis valve (Fig.16), gonoforceps (Fig.25).

Sculpture and pubescence: Head with few, scattered, irregular, inconspicuous punctures, surface opaque; thorax almost impunctate except mesonotum which is punctured like head, surface shining with general oily lustre; abdomen impunctate, shining. Body covered with silvery pubescence except for coloured parts where it appears to be golden.

Female: Not found.

Material examined: Holotype: Male, Uttar Pradesh, Kalamunitop, 2700m, 18.vi.1993. Paratypes: 3 males with same data as holotype.

Individual variations: Triangular spot on tergites 2 & 5 may be faint or missing, a yellowish spot on inner side of apex of metatibia present, black colour on metatibia extends upto 1/3 of its apical part.

Distribution: INDIA: Uttar Pradesh.

Etymology: Species name pertains to triangularly spotted abdomen.

Pachyprotasis kulwantae sp.nov. (Figs. 2,10,17,26,34,44,48)

Female: Colour: Body black, yellowish white are: underside of scape, clypeus, mandible barring apex, spot on supraclypeal area, lower 1/2 of inner and hind orbits (Fig.48); sagittated apex of mesonotal middle lobe, tegula, spot before mesoscutellum, mesoscutellum except lateral slopes, a spot each on appendage and metascutellum; lower haves of meso- and metapleura; extreme posterior margins of tergites 3-7 triangularly widened in middle, posterolateral deflexed sides of stergites 3-8 more or less, posterior margins of sternites 3-7; all coxae and trochanters; femora, tibiae and tarsi of front four legs except posterior stripe; basal 1/3 of metatibia. Fuscoferruginous are: apical 2/3 of metafemur except an apical black dot, basal 2/3 of metatibia, all metatarsi. Wings hyaline; costa and basal 1/3 of stigma fulvous, rest of venation piceous.

Structure: Length 7.5mm. Antenna 3.2x head width, segment 3 equal to 4; clypeus (Fig.2) subrectangularly incised upto 1/3 of its medial length, labrum broader than long as 3:2 with rounded anterior margin, malar space 0.5x diameter of median ocellus; LID:IDMO:EL = 1:1:1, OOL:POL:OCL = 3:2:2; frontal area below level of eyes; supraantennal tubercles raised and confluent with slightly indicated frontal ridges, supraantennal pit shallow, median fovea ditch-like in its anterior 1/2 and posteriorly shallowly reaching median ocellus; postocellar furrow shallow, interocellar furrow just indicated, circumocellar furrow absent, lateral furrows distinct and ending just before hypothetical hind margin of head; postocellar area subconvex and as wide as long; mesoscutellum pyramidally raised (Fig.44), appendage carinate, ICD:ITD = 2:5; metafemur longer than tibia as 9:7, metabasitarsus longer than following 3 joints combined as 5:4, IATS:MB:OATS = 3:5:2, apical tooth of tarsal claw longer than subapical one (Fig.10). Lancet (Fig.34) with 20 serrulae.

Sculpture and pubescence: Head covered with dense, minute, conspicuous punctures, surface opaque; thorax with fine, inconspicuous, scattered punctures, surface subshining. Body covered with mixed blackish and silvery pubescence except for coloured parts where it appears golden.

Male: Average length 6.5mm. Similar to female except: underside of antenna yellowish white, metabasitarsus apically ringed with black. Genitalia: Penis valve (Fig.26), gonoforceps (Fig.34).

Material examined: Holotype: Female, Uttar Pradesh, Kalamunitop, 2700m, 18.vi.1993. Patatypes: 2 males with same data as holotype.

Individual variations: Triangular spots on tergites missing.

Distribution: INDIA: Uttar Pradesh.

Etymology: Species name is in honour of Dr. Kulwant Kaur, wife of the first author, who has given a lot of moral support to run the project under which this work has been completed.

Pachyprotasis cephalopunctata sp.nov.
(Figs. 7,35,46,49)

Female: Colour: Body black, yellowish are: underside of scape, clypeus except a medial basal spot, labrum, mandible barring apex, spot on supraclypeal area, paired spot above bases of antennae, broad inner orbit narrowly continues with a spot on temple (Fig.49), lower 2/3 of hind orbit; anterior and posterolateral margins of pronotum, tegula, lateral side and sagittated apex of mesonotal middle lobe, spot before mesoscutellum, top of mesoscutellum, appendage, spot on metascutellum; a broad transverse band on lower half of mesepisternum, a broad spot on metasternum, posterior margin of mesepimeron, lower 1/2 of metapleuron; a spot each on posteromesal margins of propodeum, narrow posterior borders of tergites 2-4 and entire 9, posterior margin of deflexed lateral sides of all tergites, posterior borders of sternites 4-7; coxae, trochanters and adjoining parts of femora of front four legs; a medial broad spot more or less covering apical 1/2 of metacoxa, metatrochanter and adjoining part of metafemur, anterior aspect of profemur, extreme bases of meso- and metafemora; inner side of pro- and mesotibiae, inner aspects of tarsi of front four legs. Fuscoferruginous are: posterior aspect of profemur except extreme bases and apices, metatibia except apical 1/3 and a black dot on dorsal aspect of extreme base. Wings hyaline; venation including costa, subcosta and stigma piceous.

Structure: Average length 8mm. Antenna 3.1x head width, segments 3 and 4 as 4:5; clypeus (Fig.5) roundly incised upto 1/2 of its medial length, labrum broader than long as 3:2 with rounded anterior margin, malar space 0.5x diameter of median ocellus; LID:IDMO:EL = 6:7:6, OOL:POL:UCL = 3:2:3; frontal area below level of eyes; supraantennal tubercles and frontal area below level of eyes; supraantennal tubercles and frontal ridges insignificant; supraantennal pit deep, crescent-shaped in outline; median fovea shallowly indicated in its anterior half; post-, inter- and circumocellar furrows distinct; lateral furrows deep, distinct and ending just before hypothetical hind margin of head; postocellar area subconvex, broader than long as 3:2; mesoscutellum flat (Fig.46), appendage carinate, ICD:ITD = 2:7; metafemur longer than tibia as 7:6, metabasitarsus longer than following 3 joints combined as 5:4; IATS:MB:OATS = 3:5:2, apical tooth of tarsal claw equal to subapical one (Fig.12). Lancet (Fig.35) with 23 serrulae.

Sculpture and pubescence: Head with scattered, inconspicuous punctures, surface shining; mesonotum with dense, minute, shallow punctures, surface shining with general oily lustre; mesoscutellum bears few, isolated punctures on its posterolateral slope, surface polished, appendage polished; mesepisternum with dense, deep and confluent punctures, surface shining; mesosterna with dense, fine, shallow punctures, surface shining with general oily lusture; abdomen impunctate, cross-striated, subshining. Body covered with silvery pubescence except yellowish parts where it seems to be golden.

Male: Not found.

Material examined: Holotype: Female, Manipur, Ukhrul, 1700m, 24.v.1993. Paratype: Nagaland, Zunheboto, 1874m, 1 female 14.v.1993.

Individual variations: Both specimens alike.

Distribution: INDIA: Manipur, Nagaland.

Etymology: Species name pertains to minutely punctured head.

Pachyprotasis politus sp.nov.
(Figs. 8,23,32,42,50)

Female: Colour: Body black, yellowish are: underside of scape, clypeus, labrum, mandible barring apex, spot on supraclypeal area extending beyond base of antenna, inner orbits continues with broad spot on temple, lower 3/4 of hind orbit (Fig.50); pronotum except upper 1/3, tegula, lateral margins of mesonotal middle lobe meeting at apex, spot before mesoscutellum, spot on posterolateral margin of mesonotal lateral lobe, mesocutellum except lateral sides, appendage, metascutellum, parapterum, mesepisternum and mesosternum except a dot at their borders, broad posterolateral margin of mesepimeron; metapleuron except a proximal dot on metepimeron, a broad spot on posteromesal margin of propodeum, narrow posterior margins of tergites 2-6 and 8, broad posterior margin of tergite 9, deflexed lateral sides of all tergites, all sternites entirely; all coxae and trochanters except a black medial stripe on outer ventrolateral aspect of metacoxa; femora, tibiae and tarsi of front four legs except a posterior stripe; metafemur except a stripe on outer side and another one on inner apical 1/3; a faint spot on inner side of metatibia just before apex. Wings hyaline; venation including costa, subcosta and stigma piceous.

Structure: Average length 9mm. Antenna 3.2x head width, segments 3 and 4 equal; clypeus (Fig.8) roundly incised upto 1/4 of its medial length, labrum broader than long as 4:3 with rounded anterior margin having a median notch, malar space 0.5x diameter of median ocellus; LID:IDMO:EL = 1:1:1, OOL:POL:OCL = 3:2:3; frontal area below level of eyes, supraantennal tubercles and frontal ridges insignificant, median fovea shallowly indicated in its anterior 1/2; post-, inter- and circumocellar furrows insignificant, lateral furrows absent; postocellar area almost flat, broader than long as 3:2; mesoscutellum pyramidal, appendage carinate, ICD:ITD = 2:7; metafemur longer than tibia as 8:7, metabasitarsus longer than 3 following joints combined 4:3, IATS:MB:OATS = 4:8:3, apical tooth of claw subequal to subapical one (Fig.15). Lancet (Fig.42) with 24 serrulae.

Sculpture and pubescence: Head with scattered, irregular punctures, surface subshining; mesonotum finely, densely, minutely punctured; mesoscutellum and appendage impunctate; mesopleuron and mesosternum with dense, shallow punctures, surface shining with general oily lustre; abdomen impunctate, subshining. Body covered with silvery pubescence except for yellowish parts where it appears golden.

Male: Length 7mm. Similar to female excepting underside of antenna, orbit narrowly meeting at posterior end, and metatibia except outer side and extreme tip which are yellowish white; posterior margins of all tergites broadly striped; dot on mesosternum missing; yellow colour more extensive. Genitalia: Penis valve (Fig.23), gonoforceps (Fig.32).

Material examined: Holotype: Female, Arunachal Pradesh, Sessa, 1200m, 23.v.1993. Paratypes: West Bengal, Mirik, 1700m, 1 male, 11.v.1993. Sikkim, Namchi, 1600m, 3 females, 18.v.1993. Arunachal Pradesh, Sessa, 1200m, 1 female, 23.v.1993.

Individual variations: All specimens alike.

Distribution: INDIA: West Bengal, Sikkim, Arunachal Pradesh.

Etymology: Species name is based on the smooth and shining surface of body.

Pachyprotasis cuneativentris sp.nov.
(Figs. 24,33,43,45,51)

Female: Colour: Body black, yellowish are: underside of scape and pedicel, clypeus, labrum, mandible barring apex, spot on supraclypeal area extending beyond base of antenna, broad lower 1/2 of inner orbit narrowly continuous with the spot on temple (Fig.51), hind orbit except upper 1/3; broad ventral part of pronotum, tegula except a dot on apical margin, lateral sides of mesonotal middle lobe meeting at apex, spot before mesoscutellum, mesoscutellum except lateral slopes and posterior broader, spot on appendage, metascutellum; mesepisternum except anterodorsal spot, broad posterior border of mesepimeron, mesosternum entirely, metapleuron except upper 1/2 of metepimeron, metasternum, extreme posterior margin of propodeum, medial triangular spot on tergites 2-7, tergite 9 entirely, deflexed lateral sides of all tergites, all sternites entirely; all coxae and trochanters, pro- and mesofemora except a stripe on apical posterodorsal aspect, metafemur except a stripe each on outer and inner aspects of apical 1/2, extreme base of metabasitarsus, tibiae and tarsi of front four legs except a stripe on outer aspect. Wings hyaline; venation including costa, subcosta and stigma black.

Structure: Average length 7.5 mm. Antenna 3.4x head width, segments 3 and 4 as 9:8; clypeus (Fig.4) arcuately incised upto 1/3 of its medial length, labrum broader than long as 3:2 with rounded anterior margin having a broad medial notch, malar space 0.5x diameter of median ocellus; LID:IDMO:EL = 1:1:1, OOL:POL:OCL = 5:4:5; frontal area below level of eyes; supraantennal tubercles and frontal ridges insignificant, median fovea absent, supraantennal pit deep; post-, inter- and circumocellar furrows absent, lateral furrows distinct and reaching hypothetical hind margin of head; postocellar area subconvex, broader than long as 5:4; mesoscutellum convex (Fig.45), appendage carinate, ICD:ITD = 2:7; metafemur longer than tibia as 8:7, metabasitarsus longer than following 3 joints combined as 5:4, IATS:MB:OATS = 5:8:4; apical tooth of tarsal claw equal to subapical one (Fig.12). Lancet (Fig.43) with 23 serrulae.

Sculpture and pubescence: Head almost impunctate except few, scattered, shallow punctures on and around frontal area, surface shining; mesoscutellum with dense, shallow punctures on its posterior and lateral slopes, appendage impunctate, polished; mesepister-num with dense, shallow, irregular punctures, surface shining; mesosternum with dense, minute, shallow punctures, surface shining with general oily lustre; abdomen cross-striated, surface shining. Body covered with silvery pubescence except for yellowish parts where it seems to be golden.

Male: Average length 5.5mm. Similar to female except black stripe on outer aspects of metacoxa and metatibia. Genitalia: Penis valve (Fig.24), gonoforceps (Fig.33).

Material examined: Holotype: Female, Nagaland, Pfutsero, 2100m, 20.v.1993. Paratypes: Nagaland, Vizho-Razho, 1600m, 2 females, 3 males, 11.v.1993; Zunheboto, 1874m, 1 female, 16.v.1993; Pfutsero, 2100m, 4 females, 1 male, 20.v.1993, 2 females 3 males, 14.v.1994; Akuiuto, 1500m, 3 females, 4 males, 10.v.1994. Manipur, Ukhrul, 1700m, 2 females, 23.v.1993. Meghalaya, Ladmawphlang, 1600m, 1 female, 1 male, 29.iv.1994.

Individual variations: Spot on inner orbit broadly continuous with temple in some males. Mesosternum with black spot on upper 1/2.

Distribution: INDIA: Nagaland, Manipur, Meghalaya.

Etymology: Species name pertains to abdomen having coloured triangularly elongated band.

Pachyprotasis nigricans sp.nov.
(Figs. 3,11,36,52)

Female: Colour: Body black, pale yellowish are: clypeus except extreme base and anterior margin, labrum except medial spot, mandibles barring apex, spot on supraclypeal area, narrow inner orbit confluenting with streak-like spot on temple (Fig.52), basal 2/3 of hind orbit; extreme anterior and posterolateral angles of pronotum, droplet-like spot on anterior aspect of mesepisternum, posterolateral angle of mesepimeron; deflexed lateral sides of all tergites faintly, posterior border of sternites 2-7; anterior aspect of proleg, anterior aspect of mesocoxa except a medial longitudinal band, anterior aspect of metatrochanter, dorsal aspect of mesofemur, inner aspects of mesotibia and tarsi; a broad medial apical spot on anterior aspect and a longitudinal stripe on anterolateral aspect of metacoxa, innerside of metatrochanter, extreme base of metabasitarsus, metatarsi 3 and 4 more or less. Wings hyaline; venation including costa, subcosta and stigma piceous.

Structure: Average length 7.5mm. Antenna 2.7x head width, segments 3 and 4 as 5:4; clypeus (Fig.3) arcuately incised upto 1/3 of its medial length, labrum broader than long as 3:2 with rounded anterior margin, malar space 0.5x diameter of median ocellus; LID:IDMO:EL = 3:3.5:3, OOL:POL:OCL = 3:2:2; frontal area almost at level of eyes; supraantennal tubercles and frontal ridges insignificant, supranntennal pit shallow, median fovea shallow and broadly indicated; post-, inter- and circumocellar furrows absent; lateral furrows shallow and ending at hypothetical hind margin of head; postocellar area flat, as wide as long, with median longitudinal furrow; mesoscutellum convex, appendage carinate, ICD:ITD = 1:3; metafemur longer than tibia as 7:6, metabasitarsus longer than following 3 joints combined as 5:4, IATS:MB:OATS = 3:5:2, apical tooth of tarsal claw longer than subapical one (Fig.11). Lancet (Fig.36) with 16 serrulae.

Sculpture and pubescence: Head with dense, minute and shallow punctures, surface between punctures micropunctured, surface opaque; thorax punctured like head, surface opaque; abdomen cross-striated, surface dull. Body covered with blackish pubescence.

Male: Not found.

Material examined: Holotype: Female, Uttar Pradesh, Flower valley, 3200m, 27.vii.1993. Paratype: Uttar Pradesh, Gobind Dham, 3000m, 1 female, 28.vii.1993.

Individual variations: Both specimens alike.

Distribution: INDIA: Uttar Pradesh.

Etymology: Species name alludes to general black colour of body.

Pachyprotasis salebrousa sp.nov.
(Figs. 15,18,27,37,53)

Female: Colour: Body black, yellowish white are: clypeus except a basal medial spot and extreme anterior margin, labrum, mandible barring apex, inner orbit narrowly continues with temple spot (Fig.53), lower 2/3 of hind orbit; anterior and posterolateral margins of pronotum, basal 1/2 of tegula, spot on anterolateral margins of pronotum, basal 1/2 of tegula, spot on anterolateral margin of mesonotal middle lobe not meeting at apex, top of mesoscutellum, appendage, spot on metascutellum; an irregular broad spot on anterodorsal and another irregular droplet-like spot on posteroventral margin of mesepisternum, a broad stripe along posterolateral margin of mesepimeron, narrow posterior margin of metasternum continues with broad spot on posterior margin of metepimeron; narrow posterior margin of tergite 9; spot on anterolateral, posterolateral and underturned sides of all tergites, posterior margins of sternites 3-7; anterior aspect of procoxa except a median fuscous spot, extreme apical tips of meso- and metacoxae; all trochanters except paired dot, one each on anterior and posterior aspects; femur, tibia and tarsi of proleg anteriorly; basal 1/3 of femur, tibia and tarsi of mesoleg anteriorly; basal 1/2 of metafemur; metatarsal joint 2 anteriorly; metatarsal joints 3 and 4 entirely; basal and anterior aspects of metatarsal joint 5. Wings hyaline; costa except apical swollen part fuscoferruginous, rest of venation piceous.

Structure: Average length 7mm. Antenna 3x head width, segments 3 and 4 as 8:7; clypeus (Fig.5) subsquarely to roundly incised upto 1/2 of its medial length, labrum broader than long as 5:4 with rounded anterior margin, malar space 0.5x diameter of median ocellus; LID:IDMO:EL = 4:5:3.5, OOL:POL:OCL = 3:2:2; frontal area raised upto level of eyes; supraantennal tubercles and frontal ridges insignificant, supraantennal pit shallow, median fovea insignificantly shallowly indicated; post-, inter- and circumocellar furrows shallow, lateral furrows distinct; postocellar area broader than long as 2:1; mesoscutellum flat with a carina on its posterior slope, appendage carinate, ICD:ITD = 1:4; metafemur longer than tibia as 8:7; metabasitarsus longer than following 3 joints combined as 5:4, IATS:MB:OATS = 9:12:7, apical tooth of tarsal claw longer than subapical one (Fig.15). Lancet (Fig.37) with 18 serrulae.

Sculpture and pubescence: Head with dense, minute and shallow punctures, surface between punctures microsculptured, surface opaque; thorax punctured like head, surface opaque; abdomen cross-striated, surface dull. Body covered with mixed blackish and silvery pubescence except yellowish parts where it is golden.

Male: Average length 5.5mm. Similar to female except: lower 1/2 including broad posterolateral margins of pronotum yellowish white, all yellowish white spot on mesopleuron of female comparatively broader in male, pro- and mesocoxae yellowish entirely, metacoxa with inner and outer ventrolateral stripes. Genitalia: Penis valve (Fig.18), gonoforceps (Fig.27).

Material examined: Holotype: Female, Arunachal Pradesh, Bomdila, 2550m, 6.v.1992. Paratypes: 4 females, 41 males with same data as holotype, 7 males, 9.v.1992, 2 females, 1 male, 26.v.1993.

Individual variations: All specimens alike.

Distribution: INDIA: Arunachal Pradesh.

Etymology: Species name pertains to subrugose head.

Pachyprotasis hargurmeeti sp.nov.
(Figs. 19,28,38,54)

Female: Colour: Body black; yellowish pale are: under side of scape, clypeus, labrum, mandible barring apex, spot on supraclypeal area extending beyond base of antenna; lower 1/2 of inner orbit not confluenting with temple spot (Fig.54), lower 2/3 of hind orbit; narrow anterolateral and broad posterolateral margins of pronotum; basal 1/3 of tegula, medial oblong spot on mesoscutellum, spot each on appendage and metascutellum; most of anterior aspect and transverse stripe on posteroventral 1/2 of mesepisternum, mesosternum, posterolateral margins of mesepimeron; lower 1/2 of metapleuron, metasternum; extreme posterior border of tergites 2-4, tergite 9 except anterolateral margins, deflexed lateral sides of all tergites, all sternites; front four coxae and trochanters; femur, tibiae and tarsi of front four legs except a stripe on outer aspect; metacoxa except a stripe on outer ventral aspect, metatrochanter, metafemur except a longitudinal stripe on its outer aspect widened apically to cover almost 1/2 of its inner aspect. Wings hyaline; venation including costa, subcosta and stigma piceous.

Structure: Length 8mm. Antenna 3x head width, segments 3 and 4 as 8:7; clypeus (Fig.2) subrectangularly incised upto 1/3 of its medial length, labrum broader than long as 3:2 with rounded anterior margin, malar space 0.75x diameter of median ocellus; LID:IDMO:EL = 3:3.5:3, OOL:POL:OCL = 3:2:2; frontal area at level of eyes; supraantennal pit shallow, median fovea absent; post-, inter- and circumocellar furrows absent, lateral furrows shallow; postocellar area as long as wide; mesoscutellum subconvex, appendage carinate, ICD:ITD = 2:7; metafemur equal to tibia, metabasitarsus longer than following 3 joints combined as 7:6, IATS:MB:OATS = 4:10:3, apical tooth of tarsal claw almost equal to subapical one (Fig.12). Lancet (Fig.38) with 22 serrulae.

Sculpture and pubescence: Head almost impunctate except shallow, scattered punctures on and around frontal area, surface shining; thorax except polished, impunctate appendage, with dense, minute, shallow punctures more conspicuous and confluenting on posterior slope of mesoscutellum and on convexity of mesepisternum, surface shining with general oily lustre; abdomen impunctate, shining. Body covered with silvery pubescence.

Male: Average length 7mm. Similar to female. Genitalia: Penis valve (Fig.19), gonoforceps (Fig.28).

Material examined: Holotype: Female, Uttar Pradesh, Kalamunitop, 2700m, 21.vi.1991. Paratypes: 3 males with same data as holotype. Uttar Pradesh, Mandal, 2300m, females, 7 males 16.vi.1994. Himachal Pradesh, Kufri, 2500m, 2 males, 28.vi.1994.

Individual variation: All specimens alike.

Distribution: INDIA: Uttar Pradesh, Himachal Pradesh.

Etymology: Species is named after its collector, Mr. Hargurmeet Singh.

Pachyprotasis foveatus sp.nov.
(Figs. 14,22,31,39,55)

Female: Colour: Body black, yellowish are: underside of scape, clypeus, labrum, mandible barring apex, spot on supraclypeal area extending triangularly well above base of antenna, lower 1/2 of inner orbit narrowly continuous with a prominent spot on temple (Fig.55), lower 2/3 of hind orbit; broad ventral part of pronotum, basal 1/2 of inner margin of tegula, lateral margins of mesonotal middle lobe meeting at apex, spot before mesoscutellum; a spot each on mesoscutellum, appendage and metascutellum; mesepisternum except a rectangular spot on lower 1/2 covering posterior 1/2 upto coxal rim, mesepimeron except a stripe along pleural suture, mesosternum, metapleuron except irregular stripe along pleural suture, posteromesal margins of propodeum, posterior margins of tergites 2-7, tergite 9 entirely, deflexed lateral margin of all tergites, all sternites entirely; coxae and trochanters of front four legs, metacoxa except a stripe on apical 1/2 of outer ventral aspect, metatrochanter except a spot on ventral aspect; femora, tibiae and first four tarsal joints of front four legs except a stripe on outer side; claw joint except apices of front four legs; metafemur except a spot on outer side of its base and another broad irregular spot covering apical 1/2 of anterodorsal aspect. Wings hyaline; venation including costa, subcosta and stigma piceous.

Structure: Average length 9mm. Antenna 2.6x head width, segments 3 and 4 as 8:7; clypeus (Fig.2) subrectangularly incised upto 1/3 of its medial length, labrum broader than long as 3:2 with rounded anterior margin, malar space 0.5x diameter of median ocellus; LID:IDMO:EL = 1.5:1:1.25, OOL:POL:OCL = 3:2:2, frontal area slightly below level of eyes; supraantennal tubercles and frontal ridges insignificant, median fovea shallow ditch-like in its anterior 1/2; post-, inter- and circumocellar furrows just indicated; lateral furrows distinct and ending well before hypothetical hind margin of head; postocellar area broader than long as 5:4; mesoscutellum flat, appendage carinate, ICD:ITD = 1:4; metafemur longer than metatibia as 8:7, metabasitarsus longer than following 3 joints combined as 8:7, IATS:MB:OATS = 2:6:1.5, apical tooth of tarsal claw longer than subapical one (Fig. 14). Lancet (Fig.39) with 23 serrulae.

Sculpture and pubescence: Head with dense, minute, shallow punctures more conspicuous on and around frontal area, surface shining; thorax with dense, minute, distinct punctures except posterior slope of mesoscutellum that bears large, shallow, irregular punctures, surface shining with general oily lustre; abdomen impunctate, subshining. Body covered with silvery pubescence except for yellowish parts where it is golden.

Male: Average length 6mm. Similar to female. Genitalia: Penis valve (Fig.22), gonoforceps (Fig.31).

Material examined: Holotype: Female, Uttar Pradesh, Rana, 2000m, 20.vi.1992. Paratypes: Himachal Pradesh, Sojha, 3000m, 1 female, 23.vi.1990. Uttar Pradesh, Kalamunitop, 2700m, 2 females 26.vi.1991; Auli, 2450m, 2 females, 7.vi.1992; Chopta, 3000m, 1 female, 25.vi.1992, 8 females, 15.v.1994; Munsyari, 2300m, 1 female, 2.vi.1993; Mandal, 2400m, 4 males, 16.v.1994. Sikkim, Gangtok, 1600m, 2 females, 14.v.1993.

Individual variations: All specimens alike.

Distribution: INDIA: Himachal Pradesh, Uttar Pradesh.

Etymology: Species name pertains to characteristic shape of median fovea.

Pachyprotasis pleuricingulata sp.nov.
(Figs. 41,20,29,40,56)

Female: Colour: Body black, yellowish pale are: underside of scape, clypeus, labrum, mandible barring apex, a spot on supraclypeal area extending beyond base of antenna, lower 1/2 of inner and hind orbits, temple spot (Fig.56), posterolateral margin of mesonotal middle lobe meeting at apex, mesoscutellum except lateral and posterior border, appendage, metascutellum, transverse band on lower 1/2 of mesepisternum broadened anteriorly to continue with spot on mesosternum, posterolateral margin of mesepimeron, spot on posterodorsal margin of metasternum confluenting with spot on posterior 1/2 of metepimeron; medial spots on extreme posterior margins of tergites 2-8, tergite

9 entirely, deflexed posterolateral sides of tergites 2-4, deflexed lateral sides of tergites 5-9, posterior margin of sternites 3-7; all coxae and trochanters, pro- and mesofemora except black dorsal dot on extreme proximal margin, metafemur except apical 2/5, broad inner sides of all tibiae and tarsi of front four legs. Wings hyaline; venation including costa, subcosta and stigma piceous.

Structure: Length 8 mm. Antenna 3x head width, segments 3 and 4 as 9:8; clypeus (Fig.4) arcuately incised upto 1/3 of its medial length, labrum broader than long as 3:2 with rounded anterior margin having medial notch, malar space 0.5x diameter of median ocellus; LID:IDMO:EL = 3:3.5:3, OOL:POL:OCL = 2:1:1; frontal area slightly below level of eyes; supraantennal tubercles and frontal ridges insignificant, supraantennal pit just indicated, median fovea absent; post-, inter- and circumocellar furrows shallow, lateral furrows shallow; postocellar area broader than long as 5:4; mesoscutellum subconvex, appendage carinate, ICD:ITD = 2:7; metafemur longer than metatibia as 8:7, metabasitarsus longer than following 3 joints combined as 4:3, IATS:MB:OATS = 2:5:1.25, apical tooth of tarsal claw as long as subapical one (Fig. 12). Lancet (Fig. 40) with 21 serrulae.

Sculpture and pubescence: Head with scattered, shallow punctures more conspicuous on frontal area, surface shining; mesonotum punctured like head, surface smooth and shining with general oily lustre; mesoscutellum and appendage impunctate and polished; mesepisternum with dense, prominent, confluenting punctures; mesosternum almost impunctate; abdomen cross-striated, subshining. Body covered with silvery pubescence except auratus parts where it appears golden.

Male: Average length 5.5mm. Similar to female except: underside of antenna yellowish white, black stripe on outer ventrolateral side of metacoxa present. Genitalia: Penis valve (Fig.20), gonoforceps (Fig.29).

Material examined: Holotype: Female, Nagaland, Pfutsero, 2100m, 19.v.1993. Paratypes: 4 females with same data as holotype, 1 female, 2 males, 14.v.1994; Akuiuto, 1500m, 10 males, 10.v.1994. Meghalaya, Ledmawphlang, 1600m, 1 female, 1 male, 29.iv.1994.

Individual variations: A stripe on outerside of metatibia present, posterior angles in middle of all or some tergites black, yellow lateral margin of mesonotal middle lobe not meeting at apex in some males only.

Distribution: INDIA: Nagaland, Meghalaya.

Etymology: Species name pertains to coloured band of mesopleura on its lower half.

Pachyprotasis punamae sp.nov.

(Figs. 5,12,41,57)

Female: Colour: Body black, yellowish are: underside of scape, clypeus, labrum, mandible barring apex, spot on supraaclypeal area extending above base of antenna, broad lower 1/2 of inner orbit extremely narrowly continuous with spot on temple (Fig.57), lower 2/3 of hind orbit; anterior and posterolateral margins of pronotum, basal 3/4 of tegula, lateral margins of mesonotal middle lobe meeting at apex, mesoscutellum and spot anterior to it, appendage, metascutellum, anterior broad aspect of mesepisternum continous with a spot on mesosternum, posterior margin of mesepimeron, lower 1/2 of metapleuron continuous with metasternum; posterior margins of tergites 2-8 triangularly widened in middle, tergite 9 entirely, posterior margins of deflexed lateral sides of tergites 2 and 3, deflexed lateral sides of tergites 4-9 more or less, posterior borders of sternites 3-7; front four legs except outer stripe on tibiae and tarsi; coxa, trochanter and basal 3/4 of femur of metaleg. Wings hyaline; venation including costa, subcosta and stigma piceous.

Structure: Average length 8.5mm. Antenna 3.2x head width; segments 3 and 4 as

8:7; clypeus (Fig.5) subsquarely to roundly incised upto 1/2 of its medial length, labrum broader than long as 3:2 with rounded anterior margin, malar space 0.5x diameter of median ocellus; LID:IDMO:EL = 1:1:1, OOL:POL:OCL = 3:2:3; frontal area at level of eyes; supraantennal tubercles and frontal area at level of eyes; supraantennal tubercles and frontal ridges insignificant, supraantennal pit shallow, median fovea absent, postocellar furrow shallow, interocellar furrow indicated, circumocellar furrow indistinct, lateral furrows shallow; postocellar area broader than long as 3:2; mesoscutellum convex, appendage carinate, ICD:ITD = 1:3.5; metafemur longer than tibia as 9:8, metabasitarsus longer than following 3 joints combined as 5:4, IATS:MB:OATS = 3:6:2, apical tooth of tarsal claw equal to subapical one (Fig.12). Lancet (Fig.41) with 22 serrulae.

Sculpture and pubescence: Head almost impunctate except shallow, scattered punctures, surface shining; mesonotum with dense, shallow, irregular punctures, surface shining; mesoscutellum with distinct, irregular punctures on its posterior slope, surface polished, appendage impunctate, polished; mesepisternum with distinct, large, deep, irregular punctures, surface shining with general oily lusture; mesosternum with fine, dense, shallow punctures, surface shining; abdomen cross-striated, subshining. Body covered with silvery pubescence except yellowish parts where it is golden.

Male: Not found.

Material examined: Holotype: Female, Manipur, Ukhrul, 1700m, 22.v.1993. Paratypes: West Bengal, Mirik, 1700m, 1 female, 10.v.1993. Sikkim, Namchi, 1600m, 1 female, 16.v.1993. Manipur, Ukhrul, 1700m, 1 female, 22.v.1993. Nagaland, Pfutsero, 2100m, 2 females, 19.v.1993, 2 females, 14.v.1994; Akuiuto, 1500m, 4 females, 10.v.1994.

Individual variations: Yellowish are: lower 2/3 of inner orbit, lower 1/2 of mesepisternum, posteromesal margins of propodeum, posterior margins of tergites 2 and 8, deflexed lateral sides of all tergites, sternites 6 and 7 entirely, inner median spot on tibia and extreme base of basitarsus of metaleg. Black are: apical 1/2 of tegula, lateral and posterior border of mesoscutellum, outer aspect of mesofemur.

Distribution: INDIA: Manipur, Sikkim, West Bengal, Nagaland.

Etymology: Species is named after Dr. Punam, wife of co-author, who has helped a lot to collect sawflies from various localities while collecting her elaterid beetles.

Pachyprotasis frontatus sp.nov.
(Figs. 6,13,21,30,58)

Male: Colour: Body black, yellowish white are: underside of antenna, clypeus, labrum, mandible barring apex, spot on supraclypeal area extending well above base of antenna, broad inner orbit continuous with prominent spot on temple (Fig.58), lower 3/4 of hind orbit; broad ventral half of pronotum, tegula, streak on lateral margins of mesonotal middle lobe not meeting apex, spot before mesoscutellum, top of mesoscutellum, spot each on appendage and metascutellum; mesepisternum, broad posterior margin of mesepimeron, mesosternum, metapleuron except spot on its upper 1/2, metasternum, medial triangular spot on tergites 3 and 4, deflexed lateral sides of all tergites, all sternites more or less; all coxae and trochanters, pro- and mesofemora except outer dorsolateral stripe on apical 1/3, metafemur except outer and inner aspects of apical half, tibiae and tarsi of front four legs except outer stripe, stripe on inner aspect of metatibia broadening just before its apex, extreme bases and apices of basal two metatarsal joints, metatarsi 3 and 4 entirely, extreme bases of claw joints. Wings hyaline; venation including costa, subcosta and stigma piceous.

Structure: Average length 5.5 mm. Antenna 4x head width, segments 3 and 4 as 4:5; clypeus (Fig.6) shallowly, semicircularly incised, labrum broader than long as 3:2 with truncate anterior margin, malar space 1x diameter of median ocellus; LID:IDMO:EL = 4:4:3, OOL:POL:OCL = 3:2:2; frontal ridges insignificant, supraantennal pit shallow, median fovea in form of semicircular pit in its anterior half and shallowly reaching broad shallowly depressed posterior half anterior to median ocellus; post- and interocellar furrows shallow, circumocellar furrow absent; lateral furrows deep, distinct and ending abruptly well before hypothetical hind margin of head; postocellar area subconvex, broader than long as 2:1; mesoscutellum subconvex, appendage faintly carinate, ICD:ITD = 1:4; metafemur longer than tibia as 8:7, metabasitarsus longer than following 3 joints combined as 4:3, IATS:MB:OATS = 3:5:2, apical tooth of claw equal to subapical one (Fig.13). Genitalia: Penis valve (Fig.21), gonoforceps (Fig.30).

Sculpture and pubescence: Head covered with dense micropunctures, more so on its frontal area, surface shining; thorax with fine, dense and shallow punctures, surface shining with general oily lustre; abdomen impunctate, subshining. Body covered with silvery pubescence except for yellowish parts where it is golden.

Female: Not found.

Material examined:- Holotype: Male, West Bengal, Darjeeling, 2280m, 9.v.1993. Paratype: 1 male with same data as holotype.

Individual variations: Both specimens alike.

Distribution: INDIA: West Bengal.

Etymology: Species name pertains to characteristic shape of frontal area.

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POPULATION ECOLOGY OF MIGRATORY WATERFOWL IN KEOLADEO NATIONAL PARK, BHARATPUR[1]

(*With three text-figures*)

S. Bhupathy, V.S. Vijayan[2] and R. Mathur[3]

Key words: Migratory waterfowl, ducks, population, sex ratio, Lower Critical Temperature (LCT).

Arrival, departure, sex ratio and wetland utilization by migratory waterfowl was studied in Keoladeo National Park (KNP), Bharatpur from August through May between 1987 and 1989. Direct observation method was used for data collection. Waterfowl started arriving in the KNP in the first fortnight of August and were seen till May. They extended their stay in KNP during the year of normal rainfall. Imbalance in sex ratio was observed in pintail, shoveller (male biased) and common teal (female biased). Gadwall, wigeon and mallard showed balanced sex ratio (1:1). Reasons for the disparity in sex ratio are discussed.

INTRODUCTION

Migratory waterfowl spend around eight months in a year in their wintering grounds. Knowledge of the arrival, departure, use pattern and sex ratio of the populations is a prerequisite for planning conservation strategy, especially for wintering grounds. Information on the arrival and departure of waterfowl overwintering in India is scanty (Mathew 1971, McClure 1974, Shah 1984, Ambedkar and Daniel 1990). The imbalance in sex ratio of waterfowl has been a subject of research since the mid forties in the West (Petridges 1944, Johnsgard and Buss 1956, Alford and Bolen 1977, Alexander 1983, Owen and Dix 1986). However, apart from a study on the common teal by Ambedkar and Daniel (1990), information on waterfowl sex ratio is not available for the Indian subcontinent or elsewhere in the tropics, though basic information can be found (Ali and Ripley 1983). The present study reports some aspects of population ecology of waterfowl such as arrival, departure, use of Keoladeo National Park (KNP), Bharatpur by waterfowl in terms of duck days and sex ratio. A description of the population parameters of waterfowl is given by Bhupathy (1991).

STUDY AREA

The Keoladeo National Park (KNP), Bharatpur is located between 27° 7.6' to 27° 12.2' N and 77° 29.5' to 77° 33.9' E and lies 50 km west of Agra and 180 km south of New Delhi. KNP is listed in the Convention on Wetlands of International Importance, especially as Waterfowl Habitat (Ramsar Convention) and also in the IUCN World Heritage Sites. Its total area is about 29 sq. km and about 8.5 sq. km is wetland during the years of normal rainfall. The wetland portion is compartmentalised by dykes and roads running across it. A total of 360 species of birds have been recorded from KNP by Saxena (1975) and Abdulali and Pandey (1978). However, in recent times only 317 species could be recorded (Vijayan 1987), of which about 37% (115) are water dependent. Forty-two species of anatids have been recorded from the Subcontinent (Ali and Ripley 1983) of which 24 are reported from

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KNP. Among them only four species, namely the lesser whistling teal (*Dendrocygna javanica*), spotbill duck (*Anas poicilorhynca*), comb duck (*Sarkidiornis melanotus*) and cotton teal (*Nettapus coromandelianus*) are resident in KNP.

METHODS

This study was conducted during the migratory season (from August through May) in 1987-88 and 1988-89; the former was a drought year having an estimated water input of 6.77 million cu. m and the latter (1988-89) a normal year with 13.73 million cu. m. Direct or visual count method was used to study the waterfowl. Such a method has widely been used for counting aquatic birds, especially ducks (Eltringham and Atkinson-Willes 1961, Roux 1973, Zewarts 1976, Alford and Bolen 1977, Amat 1984, Sridharan 1989). Regular rapid surveys were made once in three days to note the arrival and departure of migrants in September, October and November, and March and April respectively. The day an individual of a species was sighted for the first time, was considered as the arrival date of the particular species (Oring and Lank 1982). Similarly, the last date when an individual of a species was sighted in a particular year was considered as its departure date. Reappearance of less than 10 individuals of a departed bird species was not taken into account.

Waterfowl were counted from vantage points using a telescope (29 x) and by walking along untarred roads and dykes intersecting the aquatic area. Counts were carried out fortnightly (except in March: 3 counts) from September to May in all the years. Counts were done from half an hour after sunrise to 1100 hrs and from 1500 hrs to half an hour prior to sunset. During mid-winter when the population was very high, the counts could not be completed within a day and were extended to the next day. The movement of birds was not striking within a few days during winter and hence did not pose a serious change in overall population.

Most of the ducks developed breeding plumage from January and some of them even from December, which facilitated sex identification. Hence, from January, till the departure of all birds, sexes of sexually dimorphic species were identified and counted separately. Birds which were more than 600 m away from the observer and seen against the sun were excluded from sex ratio records. For convenience, the months before December and after January were considered as pre-winter and post-winter respectively, whereas December and January were designated as mid-winter.

Data analyses

1) Overall use of KNP by waterfowl was estimated by calculating duck days following Wilds (1975) and Thomas (1976). The population of each fortnight was taken as representative and used in the calculation as given below:

$Dd = \sum n1 \times p1 + n2 \times p2 \ldots + ny \times py$
where,
Dd = Duck days
n1 = number of days of a month (or fortnight)
p1 = population of a given species
ny = number of days in the last month (fortnight)
py = population of a given species in the last month

2) Lower Critical Temperature (LCT) for some common species was calculated using Aschoff-Pohl equation (Owen and Dix 1986).

$LCT = Tb - (4.73 \times Wt^{0.274})$
where, Tb= 40° C for non-passerine bird
0.274 is constant.

RESULTS

Arrival

The migratory waterfowl started arriving in KNP from the middle of August approximately in three batches. The first batch consisted of four

TABLE 1
ARRIVAL AND DEPARTURE OF WATERFOWL IN KEOLADEO NATIONAL PARK, BHARATPUR DURING 1987-88 AND 1988-89

	ARRIVAL		DEPARTURE	
Species	1987-88	1988-89	1987-88	1988-89
Garganey Teal	Aug. 12	Aug. 25	Apr. 27	May 16
Shoveller	Sept. 2	Sept. 10	Apr. 27	May 15
Pintail	Sept. 10	Sept. 10	Apr. 1	May 8
Coot	Sept. 10	Aug. 20	Apr. 22	May 12
Common Teal	Sept. 10	Sept. 30	Apr. 27	Apr. 27
Wigeon	Sept. 22	Sept. 30	Apr. 5	May 12
Gadwall	Oct. 28	Sept. 30	Mar. 24	May 12
Brahminy Duck	Oct. 5	Oct. 25	Apr. 15	May 7
Greylag Goose	Oct. 25	Oct. 25	Mar. 22	Apr. 12
Barheaded Goose	Nov. 3	Nov. 15	Apr. 15	Apr. 22

species, namely garganey teal, pintail, shoveller and coot. They arrived in the first half of September. The second batch had common teal, wigeon and gadwall, arriving from end September to early October. The third batch of birds arrived from the end of October to early November, and included greylag goose and barheaded goose (Table 1).

Species that arrived in September spent almost a month outside KNP, using the shallow rain-fed pools and fields in the year of normal rainfall i.e. 1988-89. However, in the drought year 1987-88, when these waterbodies were dry, they arrived directly at KNP. Even though both the species of goose arrived as early as October, their numbers increased only by the end of November or early December. Garganey teal built up their number and reached a peak in the early part of the migratory season (ie. before mid October), declined sharply in the end of November; virtually none but a hundred birds remained in KNP.

Departure

The return migration of the waterfowl population started in mid February and most of them left KNP by the end of March. The first species to leave KNP was the greylag goose followed by the barheaded goose (Table 1). The dabblers were the last to leave and were seen till the end of April or early May in the year of normal rainfall (1988-89). The migratory waterfowl extended their stay that same year, and each species, at least in small numbers, stayed 20-40 days more than they did during the drought year (Table 1).

Use of KNP by waterfowl (duck or bird days)

The use of KNP by waterfowl is expressed in terms of duck or bird days (Wilds 1975, Thomas 1976). The use of KNP during 1988-89 was 18,95,197 bird days, whereas it was only 9,44,196 during 1987-88 (Table 2). This was because, in 1988-89, the population of species such as greylag goose, pintail and coot was 5, 3.5 and 2.5 times higher respectively than in 1987-88, the drought year. Also, most of the species extended their stay further (Table 2).

TABLE 2
GENERAL USE OF KEOLADEO NATIONAL PARK BY SOME WATERFOWL SPECIES DURING 1987-88.

Bird species	1987-88		1988-89	
	No. of days seen	Bird/ Duck day	No. of days seen	Birs/Duck day
Greylag Goose	163	28149	166	150097
Barheaded Goose	172	86008	132	51619
Pintail	207	129655	242	499447
Common Teal	226	180788	208	228892
Gadwall	148	107471	222	128827
Wigeon	194	33503	222	24373
Garganey Teal	261	29015	263	74439
Shoveller	238	108858	250	121515
Redcrested Pochard	71	7821	111	14893
Common Pochard	88	3163	146	43231
Coot	224	198302	263	481589
Total		944196		1895197

Excepting the barheaded goose, brahminy duck, mallard and wigeon, all the other species showed an overall increase in the usage of KNP in the normal year. Out of 11 species of common waterfowl recorded in KNP, seven species spent

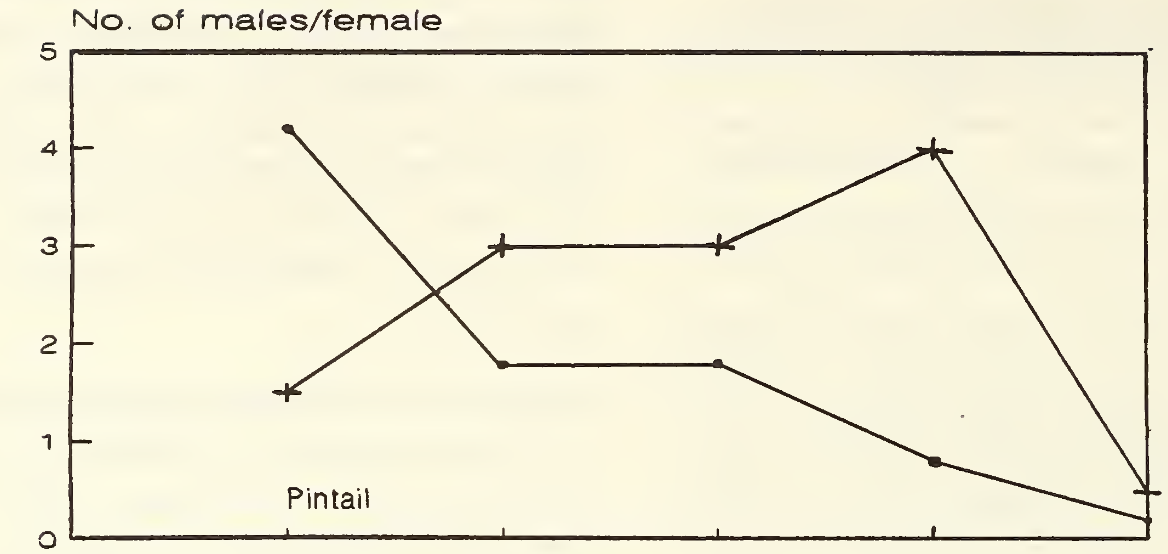

Fig. 1

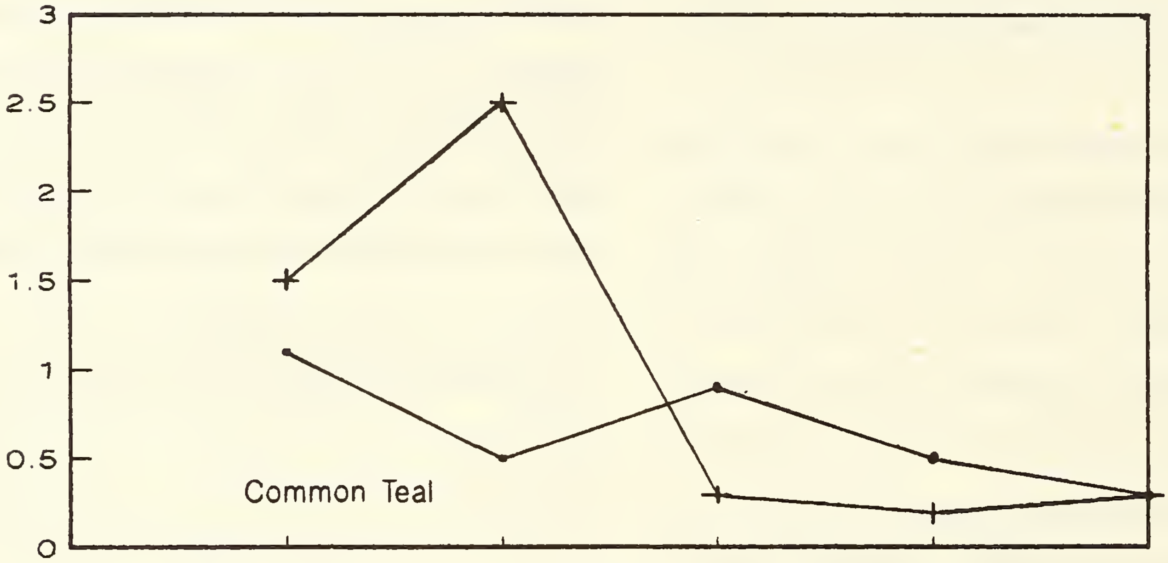

Fig. 2

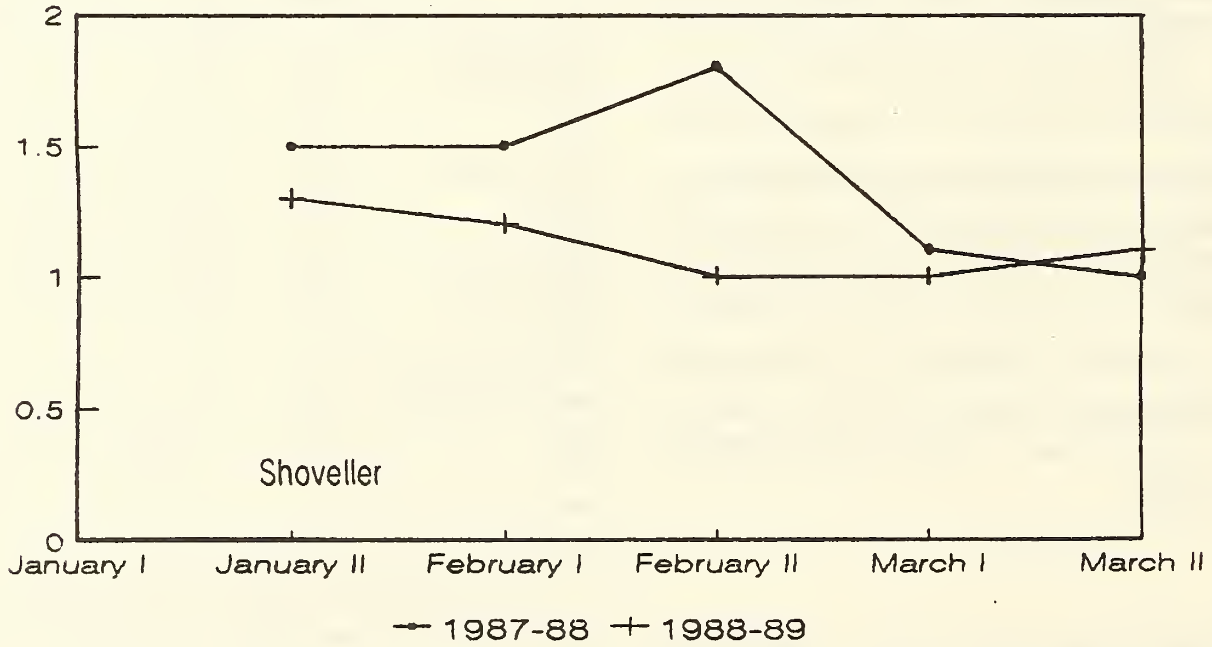

Fig. 3

Fig. 1-3: Sex ratio of 1. Pintail; 2. Common Teal and 3. Shoveller in Keoladeo National Park, Bharatpur during 1987-88 and 1988-89

more than seven months in a year. The barheaded goose and common teal had a shorter stay in the year of normal rainfall (Table 2), compared to other species.

Sex ratio of some migratory waterfowl

Six species of dabbling ducks; pintail, common teal, gadwall, mallard, wigeon and shoveller, in which sexual dimorphism was distinct, were seen in large numbers (>100) and were taken for this study. The garganey teal was left out of the analysis as they were in eclipse plumage till March, which would have led to bias in sexing (Eltringham 1973).

Preponderance of males in the population was observed in all species except the common teal, in which the females outnumbered the males (Table 3). The maximum disparity in the sex ratio over the years was recorded in pintail, followed by shoveller. In shoveller, the ratio was balanced in 1988-89 (ie. close to 1:1) but it was 1.5 : 1 (male per female) in 1987-88. The gadwall, wigeon and mallard showed a similar sex ratio during the study period (1:1; Table 3).

TABLE 3
OVERALL SEX RATIO (MALES:FEMALE) OF SOME WATERFOWL DURING 1987-88 AND 1988-89.

Name of the bird	Male:Female	
	1987-88	1988-89
Pintail	1.83:1	2.31:1
Common Teal	0.55:1	0.79:1
Shoveller	1.47:1	1.11:1
Gadwall	1.02:1	1.03:1
Wigeon	1.13:1	1.00:1
Mallard	1.01:1	-

- not included (sample size <50 birds).

Fortnightly variation

The gadwall, mallard and wigeon showed no change in sex ratio in different fortnights, but it varied in pintail, common teal and shoveller. The preponderance of males was seen in mid-winter (December-January) and to some extent in early post-winter (February) in pintail and common teal (Fig. 1). In the shoveller also, males dominated the population till February during 1987-88, but afterwards the sex ratio became balanced (Fig. 1).

DISCUSSION

The arrival and departure schedules of most of the migrant waterfowl are generally known (Ali and Ripley 1983, McClure 1974). A study on the migratory waterfowl at Hokarsar by Shah (1984) shows that the arrival in Kashmir Valley was August-September. This shows that the arrival and dispersal of migratory waterfowl takes place more or less at the same time in North India.

During the normal rainfall year, in September and October the inundated areas of KNP have a water depth between 1 and 2.5 m. As the area was freshly inundated, no submerged vegetation was observed during this period. Water was also available in the wetlands outside KNP. On the other hand, in the drought period water was available only inside KNP. This could be the reason for the early arrival of waterfowl in KNP during the drought years (1987-88, Table 1). As in the present study, the early arrival and staging of garganey teal in KNP was reported by McClure (1974) and Ali and Ripley (1983).

The extended use of KNP by waterfowl in a normal year was either due to the arrival of birds in larger numbers on transit from the wintering areas possibly south of Bharatpur, or on their return to the breeding ground. Early departure (Table 1) of most of the waterfowl in 1987-88 was due to the early drying up of marshes consequent to drought. Apart from water conditions and climate (Flickinger 1981, Schladweiler 1986), the breeding strategy of individual species also determines the departure chronology of species. However, in KNP, water level appears to play a major role in the arrival and departure of waterfowl.

The variation in use of KNP between 1987-88 and 1988-89 was mainly due to the difference in the availability of waterspread area. The barheaded goose and wigeon need partly dry marsh with grass for feeding and resting (Bhupathy 1991), which was abundant during the drought year 1987-88 and hence, they were inside KNP for more days i.e. 9,51,001 duck days (Table 2). Also, the higher water level in the normal year affected adversely the usage of KNP by barheaded goose and wigeon. It may also be noted that encroachment by *Acacia nilotica* and *Prosopis juliflora* in the traditional goose grazing and resting areas might also have reduced the duck days. As these migratory birds spend more than half or two thirds of their life annually in the wintering area, KNP plays a vital role in their conservation when they build up energy during this period, for a successful return migration.

Disparity in the sex ratio of waterfowl is a worldwide phenomenon (Johnsgard and Buss 1956, Alford and Bolen 1977, Bennet and Bolen 1978, Alexander 1983). Alford and Bolen (1977) suggested that winter temperature was responsible for this disparity in the sex ratio of the pintail in North America. In this study, the case of the common teal supports the ring recovery data gathered between 1965 and 1974 in KNP, Bharatpur (1:1.7, male: female, n = 10,555) by Ambedkar and Daniel (1990).

The change in the ratio in favour of one sex within a season indicated differential or independent movement, or differential habitat use of sexes in the pintail, common teal and to some extent in shoveller. Early departure of males to the breeding ground, and influx of females which wintered further south, on their return journey, might have caused this reversal. Early migration of males to the breeding ground has been reported in canvasback (Welling and Sladen 1979) and common teal (Ambedkar and Daniel 1990). Also, differential migration of sexes was reported in mallard (Salomonsen 1968, Ogilvie and Cook 1971). Ambedkar and Daniel (1990) compared two methods, namely catching (trapping) and hunting records for assessing sex ratio and reported almost similar results ie. 1:1.7 in trapping, 1:1.2 in shooting. The direct count method used in the present study also yielded an almost similar figure, 1:1.5.

Theories which discuss the imbalance in the sex ratio of birds, especially waterfowl, are: (1) behaviour dominance (2) breeding strategy and (3) cold hardiness or stress theory.

(1) The behaviour dominance theory discussed by Hepp and Hair (1984) and Oring and Lank (1982), suggests that male displaces female by aggression. In the present study, among shovellers, when the waterspread area was less in the drought year, the male population was higher (Table 3). Perhaps the displacement of females by male aggression resulted in a disparate sex ratio. Alternatively, differential habitat requirement of each sex (Rappole and Warner 1980) which could not be tested in the present case may be responsible. Male dominance in intersexual competition has been established in canvasback and ringnecked duck (Alexander 1983).

(2) The pairing chronology theory proposed by Hepp and Hair (1984) suggests that birds pairing early would have less disparity in the sex ratio and in their study on waterfowl they indicated that gadwall, wigeon and mallard are early pairing species. The balanced sex ratio in these species in the present study (Table 3) complements the above view. Soon after their arrival in KNP in October, gadwall, wigeon and mallard began pair formation and most of them had paired by the end of November. Pintail, common teal and shoveller were noted to be late pairing birds by Hepp and Hair (1984). The higher disparity in the sex ratio in these birds in KNP also supports their findings.

(3) Cold hardiness/stress theory by Alexander (1983) and Owen and Dix (1986) states that to avoid the cold, smaller sized females migrate to warmer localities (further south). The authors consider this to be the reason for the imbalance in the sex ratio in the wintering grounds.

TABLE 4
LOWER CRITICAL TEMPERATURE OF FIVE WATERFOWL AT KNP

Bird	Sample size	Weight	LCT
Pintail			
Male	32	898.4	9.5
Female	19	712.6	11.4
Common Teal			
Male	13	315.5	17.1
Female	75	286.5	17.7
Gadwall			
Male	14	749.6	11.0
Female	15	675.6	11.8
Wigeon			
Male	24	701.6	11.5
Female	51	629.4	12.4
Shoveller			
Male	23	535.0	13.6
Female	49	507.8	13.9

$LCT = Tb - (4.73 * Wt^{0.274})$, $Tb = 40$ for non-passerine birds
Wt = weight of the bird, constant = 0.274

To test the above hypothesis, Lower Critical Temperature (LCT) was calculated for five common waterfowl species (Table 4). LCT is the minimum temperature which an animal can withstand without the loss of metabolic energy (Owen and Dix 1986). The range of LCT for five common species varied from 9.5°C to 17.7°C (Table 4). The minimum LCT obtained for the pintail was 9.5°C for male and 11.4°C for female, showing the ability of both sexes of this species to withstand an atmospheric temperature as low as 9.5°-11.4°C without losing metabolic energy. The common teal had the highest LCT among all the species studied (17.1°C and 17.7°C for the male and female respectively). This shows that under prolonged low atmospheric temperature (17°C), this species would need to utilize metabolic energy to keep the body warm. In this situation the common teal might migrate to warmer places. Even though the mean maximum atmospheric temperature during December-April did not get lower than the LCT of any of the common species studied, the minimum temperature was well below the LCT of all the species during December-February (Table 5). Hence, winter temperature might also affect the sex ratio of waterfowl. Whether the duration of minimum temperature was sufficient to force the common teal to move is not known.

The behaviour dominance and pairing chronology theory are applicable to some extent in the present study. Hence, one or more of the factors such as behaviour among sexes, breeding strategy of species, differential habitat requirement of sexes and winter temperature might influence the sex ratio of waterfowl in KNP. Differential habitat requirement by each sex in various waterfowl needs to be further studied, especially species such as common teal where the LCT of male and female, i.e 17.1° and 17.9°C does not vary much.

TABLE 5
MEAN MAXIMUM AND MINIMUM ATMOSPHERIC TEMPERATURE RECORDED BETWEEN JANUARY AND APRIL

MONTH	MAXIMUM		MINIMUM	
	1988	1989	1988	1989
Dec.	34.2	24.7	7.4	6.8
Jan.	20.9	20.3	7.8	5.1
Feb.	26.3	23.2	8.2	8.6
Mar.	31.9	30.0	13.4	14.8
Apr.	42.1	36.0	21.4	19.9

ACKNOWLEDGEMENTS

This paper resulted from the Bombay Natural History Society and U.S. Fish and Wildlife Service collaborative project on the Ecology of Keoladeo National Park, Bharatpur, sponsored through the Ministry of Environment and Forests, Government of India. We thank the Rajasthan State Forest Department for permission to work and co-operation. We also thank Mr. Rajan Mathur, then Divisional Forest Officer in-charge of the Park and his colleagues for their help in the field, Mr. J. C. Daniel, BNHS for his critical comments and encouragement and Dr. Lalitha Vijayan, Sálim Ali Centre for Ornithology and Natural History, Coimbatore and Mr. Melvin Bolton, FAO Consultant, Wildlife Institute of India, Dehra Dun for their comments.

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THE GENUS *MACROCHELES* LATREILLE (ACARINA: MACROCHELIDAE) IN INDIA* MORPHOLOGICAL VARIATIONS AND GEOGRAPHICAL DISTRIBUTION[1]

RANJIT KUMAR ROY[2]

(*With five text-figures and one plate*)

Key words: Acarina, *Macrocheles* sp., habitat, morphological variation, distribution

Data pertaining to habitats and geographical distribution of five species of *Macrocheles* Latreille, viz. *peniculatus* Berlese, *penicilliger* (Berlese), *krantzi* Evans and Hyatt, *merdarius* (Berlese) and *muscaedomesticae* (Scopoli) are presented. Morphological variations observed in the first two species are discussed with illustrations.

INTRODUCTION

This part of the series documents the data pertaining to habitats and geographical distribution of five species of *Macrocheles* Latreille, viz. *peniculatus* Berlese, *penicilliger* (Berlese), *krantzi* Evans and Hyatt, *merdarius* (Berlese) and *muscaedomesticae* (Scopoli) from India. Morphological variations observed in *peniculatus* and *penicilliger* are discussed and illustrated. Of the five aforenamed species, *peniculatus* was earlier reported in Part 2 of the series (Roy 1991 a). The remaining are known through the works of Evans and Hyatt (1963), Pramanik and Raychaudhuri (1968), Pramanik (1977), Sharma and Sharma (1973) and Singh and Kapoor (1976). This paper incorporates additional information on habitats.

Unless otherwise indicated, the collector was this author. The material has been deposited in the Zoological Survey of India, Calcutta. The altitudes given are approximate.

1. *Macrocheles peniculatus* Berlese, 1918
(Figs. 1-2; Pl. 1: Fig. 1)

Macrocheles (*Coprholaspis*) *peniculatus* Berlese, 1918, *Redia* 13: 166.

Macrocheles vicarius Berlese, 1918, *Redia*, 13: 167

Macrocheles caelatus: Ramsay, 1970, *N. Z. Entomologist*, 1: 91;

Emberson, 1973, *N.Z. Entomologist*, 5: 119 (not Berlese, 1918) misidentification.

Macrocheles peniculatus: Ghilyarov and Bregetova, 1977 (Nauka, Leningrad): Wallace, 1986, *Acarologia*, 27 (1): 11.

Material examined: 5 females, Tamil Nadu: Palni Hills: Kodaikanal - 2450 m, 12.iii. 1980, ex dung heap; 1 female, Kodaikanal lake area, 12.iii. 1980, ex decaying grasses; 2 females, Nilgiri Hills: Ootacamund, Botanical Garden, 16.iii.1980 ex dung heap; 1 female, Ootacamund, 16.iii.1980, ex pine leaf litter; 1 female, Nilgiri Hills: Aruvankadu - 2000 m, 18.iii. 1980, ex pine leaf litter; 2 females, Nilgiri Hills; Pykara -2290 m, Royal valley, 10.iii. 1980, ex pine leaf litter.

Distribution: Originally described as an ant nest associate from La Plata, Argentina in South America (Berlese, 1918). Krantz (1970) recorded the species from Natal (South Africa). Wallace (1986) collected the species from a number of dung beetles in Australia. Krantz and Filipponi (1964) reported a female of *M. peniculatus* from Australia. According to Wallace (*op. cit.*), the record was an error and the actual locality of that specimen is Otaki, north of Wellington, New Zealand. Previous records of *M. caelatus* Berlese, 1918 from New Zealand by Ramsay (1970) and Emberson (1973) are misidentifications of *M. peniculatus* (Emberson,

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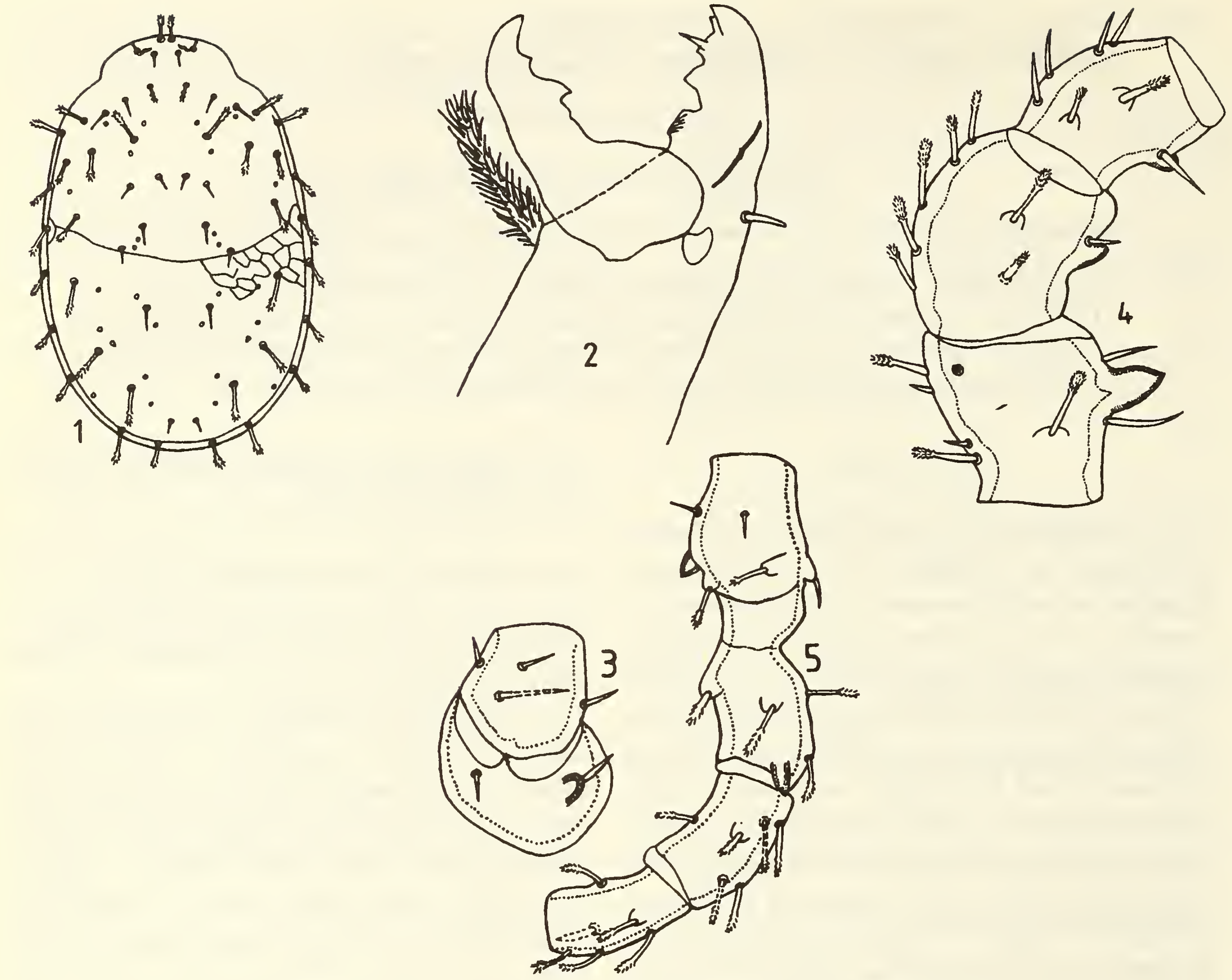


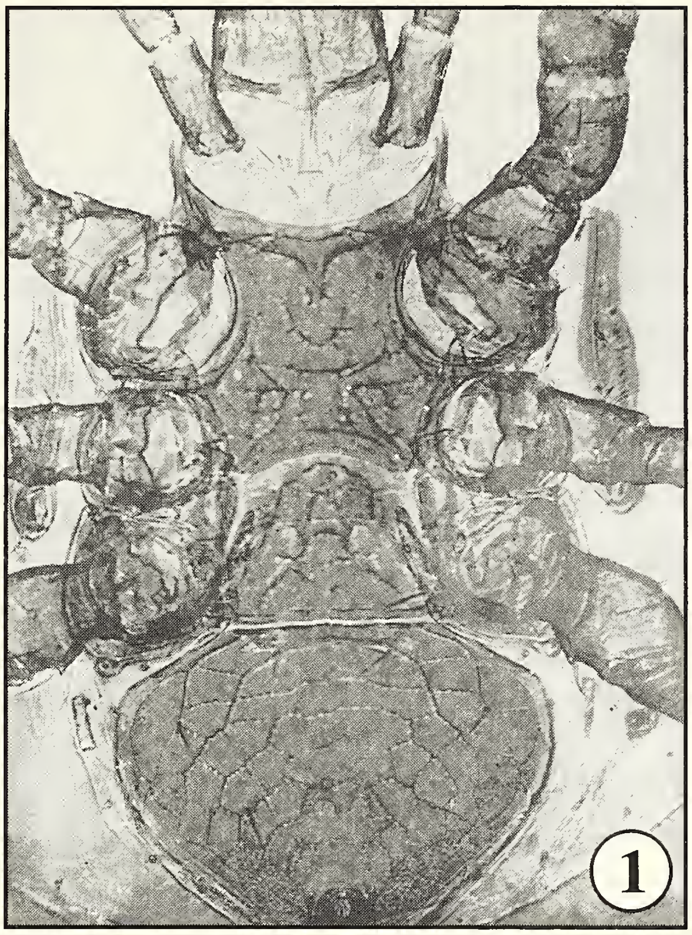
Figs. 1-5: 1. Dorsal shield, *Macrocheles peniculatus* Berl., female; 2. Chelicera, *Macrocheles peniculatus* Berl., female; 3. Coxa II, *Macrocheles penicilliger* Berl., male; 4. Femur, genu and tibia of leg II, *Macrocheles penicilliger* Berl., male; 5. Trochanter, femur, genu and tibia of leg IV, *Macrocheles penicilliger* Berl., male.

1980). European records are from USSR (Bregetova and Koroleva 1960), Ghilyarov and Bregetova 1977) and Hungary (Eröss and Mahunka 1971). Costa (1966) recorded it from Israel. In India, it is confined to the southern region. Records indicate that the species is well represented in the southern hemisphere.

Remarks: The species has been described and illustrated by Bregetova and Koroleva (1960). The material at hand conforms to the description and illustration given by Bregetova and Koroleva (*op. cit.*) except for the presence of a procurved medial line and dorsal seta (s4) being simple (Fig. 1). In addition, the movable digit of chelicera (Fig. 2) is tridentate in contrast to the bidentate nature of the digit in the European counterpart, as depicted by Bregetova and Koroleva (1960). It was reported earlier from Kodaikanal by Roy (1991a, b).

2. ***Macrocheles penicilliger*** (Berlese, 1904)
(Figs. 3-5; Pl. 1; Figs. 2-3)

Holostaspis penicilliger Berlese, 1904, *Redia,* 1: 264 *Macrocheles* (*Coprholaspis*) *penicilliger* Berlese, 1918, *Redia,* 13: 146.



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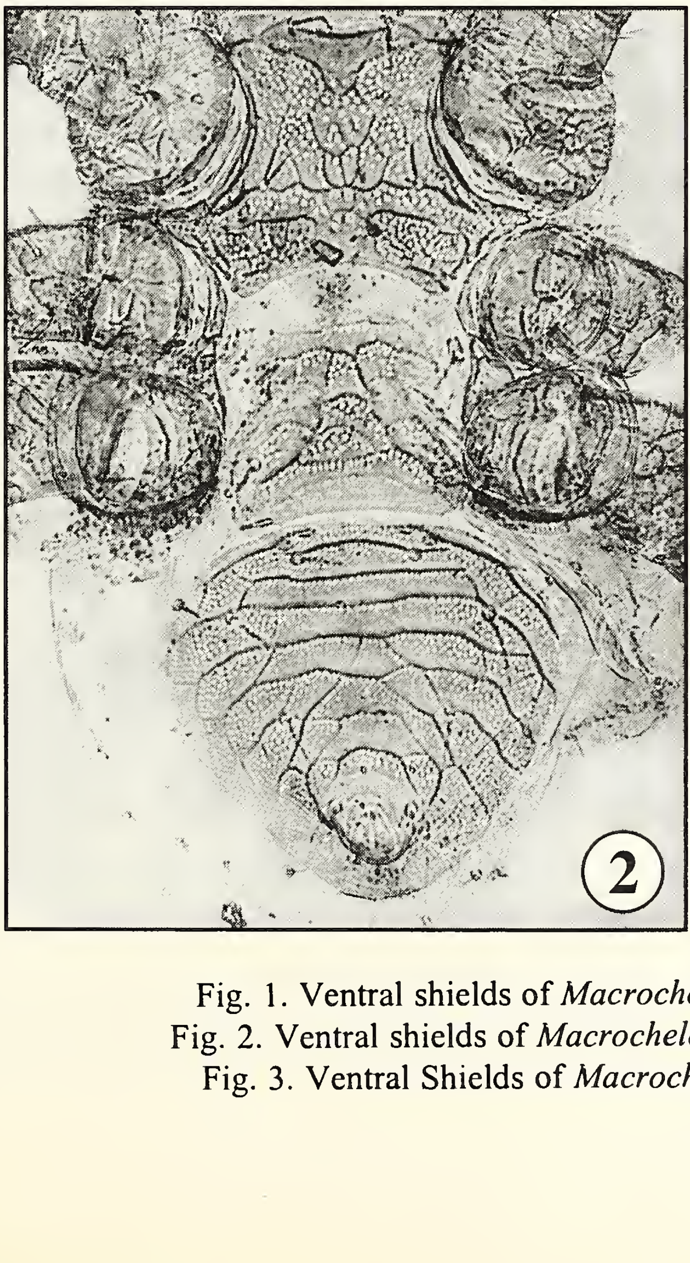

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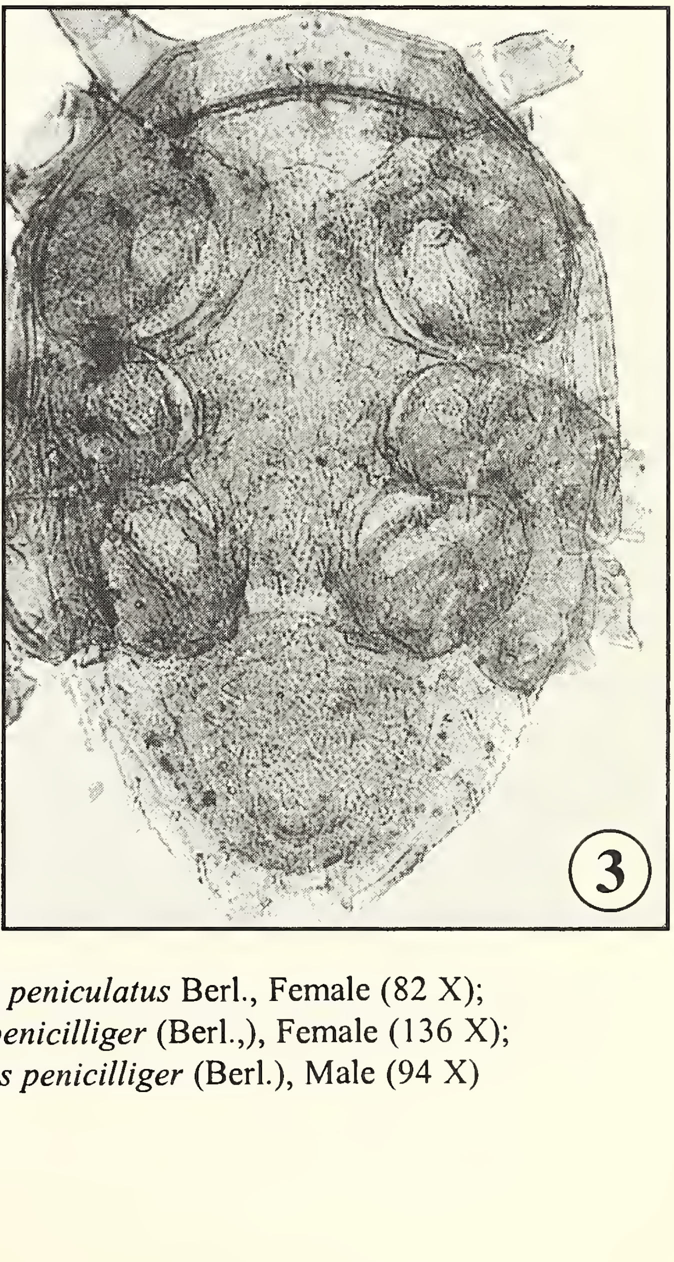

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Fig. 1. Ventral shields of *Macrocheles peniculatus* Berl., Female (82 X);
Fig. 2. Ventral shields of *Macrocheles penicilliger* (Berl.,), Female (136 X);
Fig. 3. Ventral Shields of *Macrocheles penicilliger* (Berl.), Male (94 X)

Macrocheles penicilliger: Bregetova and Koroleva, 1960, *Mag. Parasit. Sbornik. Zool. Inst. 19*: 86.

Macrocheles (*Macrocheles*) *penicilliger* Krauss, 1970, *Acarologie Sch. vergl. Milbenk, 14*: 18.

Material examined: 7 females, Manipur: Imphal -780 m, War Cemetery, 31.xi.1973, ex decaying leaf litter; 8 females, Meghalaya: Khasi Hills: Shillong -1300 m, lake area, 8.vi.1974, ex soil litter; 6 females, Shillong, Trevors Lane, 13.vi.1974, ex soil litter; 1 female, Shillong, Umpling, 8.vi.1974, ex grassy soil; 2 females, Shillong, lake area, 11.vi.1974, ex leaf litter; 4 females, Shillong, Umpling, 8. vi. 1974, ex pine leaf litter; 1 female, Meghalaya: Garo Hills: Tura-370 m, 15.iii.1974, ex decaying grasses; 1 female, Bonsomgiri, 14.iii.1977, ex decaying wood; 2 females, Sikkim: Gangtok-1500 m, 10.xi.1973, ex decaying litter of *Bambusa* sp.; 123 females, Gangtok, Sundarigaon, 11.xi.1973, ex soil mixed with dung; 1 female, Gangtok, near White Memorial Hall, 9.xi.1973, ex decaying heap of grasses; 17 females, Gangtok, 12.xi.1973, ex cultivated soil mixed with dung; 2 females, Tamil Nadu; Nilgiri Hills: Coonoor - 2090 m, ex pine leaf litter; 1 female, Pykara -2290 m, 10.iii.1980, ex pine leaf litter; 2 females, Ootacamund -2218 m, Botanical Garden, 16.iii.1980, ex humus soil; 1 female, Pykara, Royal Valley, 10.ii.1980, ex soil litter; 1 female, Palni Hills; Kodaikanal-2450 m, lake area, 10.iii.1980, ex dung mixed with straw; 3 females and 2 males, Uttar Pradesh: Garhwal Hills: Pauri -775 m, Stn. No. 10, 25.xi.1977, ex leaf litter. S.K. Gupta and Y.N. Gupta coll.; 3 females, Kumaon Hills: Nainital -1985 m, 11.xi.1977, ex leaf litter, S.K. Gupta and Y.N. Gupta coll.; 9 females, Nainital, near Nainital Lake, 16.xi.1977, ex rotten grasses, Y.N. Gupta coll.; 23 females, Almora -1645 m, 9.x.1976, ex leaf litter; 5 females, Kumaon Hills: Kausani -1800 m, 13.x.1976, ex pine litter; 1 female, Almora, Chitoli Reserve Forest, 9.x.1976, ex decaying heap of grasses; 2 females, Kathgodam -500 m, 8.x.1976, ex decaying grasses; 1 female Ranikhet -1805 m, Mall Road, 12.x.1976, ex moss; 2 females, Ranikhet -1805 m, Chaubatia Apple Garden, 10.x.1976, ex leaf litter; 3 females, Almora, 9.x.1976, ex leaf litter; 17 females, Eastern Himalaya: West Bengal: Darjeeling -2800 m, Hill Cart Road, 14.xi.1973, ex soil litter; 13 females, Darjeeling, Labong, College Road, 13.xi.1973, ex garbage heap; 22 females, Darjeeling, Botanical Garden, 13.xi.1973, ex decomposed grasses and leaves; 39 females Darjeeling, Mall area, 15.xi.1973, ex rubbish heap; 2 females, Selimbong, 7.xii.1977, ex soil with pine litter, R.K. Ghosh Sr. ZSI Coll.; 1 female, Dow Hills: Kurseong-2350 m, 13.v.1979, ex pine litter, M.S. Shishodia *et al.* ZSI Coll.

Distribution: *M. penicilliger* is frequently encountered in Europe: Italy (Berlese 1904), England (Evans and Browning 1956), Austria (Franz 1954), Hungary (Eröss and Mahunka 1971), Iceland (Sellnick 1940), USSR (Bregetova and Koroleva 1960), Germany (Krauss 1970). Pramanik and Raychaudhuri (1978) first recorded females of *M. penicilliger* from India: The species is an exotic in India, away from its Palearctic homeland and is widely represented. India. Manipur, Meghalaya, Sikkim, Tamil Nadu, Uttar Pradesh and West Bengal. This species was first recorded from West Bengal (Pramanik and Raychaudhuri 1978). Others are new records.

Remarks: In recent years the species has been redescribed by Evans and Browning (1956) and by Bregetova and Koroleva (1960), based on material collected in England and USSR. Indian material conforms with the European material. Pramanik (1977) provided collection data from West Bengal, with measurements of female. Males are recorded here for the first time. Bregetova and Koroleva (*op. cit.*) illustrated both the sexes. The nature of spurs and ridged setae on legs II and IV in male in Indian material differs from USSR specimens as illustrated by these authors. Segments of legs II and IV in male, bearing spurs and ridged setae, are illustrated in Figs. 3-5. Coxa II bearing sclerotised ridge (Fig. 3); femur, genu and tibia of leg II spurred (Fig. 4). Segments of leg IV provided with plumose and ridged setae (Fig. 5); trochanter and femur IV with spurs (Fig. 5).

3. ***Macrocheles krantzi*** Evans and Hyatt, 1963.

Macrocheles krantzi Evans and Hyatt, 1963, *Bull. Brit. Mus.* (*Nat.*) *Hist., 9*: 351.

Macrocheles krantzi (7) Krantz and Filipponi, 1964, *Riv. Parass., 25(1)*: 44

Not *Macrocheles krantzi,* Anwarullah and Irshad, 1971, *Sind Univ. Res. J.* (*Sci. Ser.*),: 145. (misidentification).

Macrocheles krantzi: Wallace, 1986, *Acarologia, 27(1)*: 12.

Material examined: 1 female, Assam: Nowgong dist. Lumding, 29.xii.1973 ex goat dung; 1 female, Karnataka: Bangalore, Entomology Museum, University of Agricultural Sciences, coll. date and coll. not listed, ex *Scarabaeus brahminus* Cast.

Distribution: Australia (Krantz and Filipponi 1964, Wallace 1986), India and Ceylon (Evans and Hyatt 1963). India: Assam (new record), Karnataka (new record) and Tamil Nadu.

Remarks: This species was originally described by Evans and Hyatt (1963) from specimens collected from *Scarabaeus brahminus* Cast. at Namakal, Salem (Tamil Nadu) and *S. erichsoni* Harold at Colombo (Sri Lanka) respectively, both the beetles are represented in the British Museum collections. Subsequently Krantz and Filipponi (1964) reported three specimens from Townsville, Australia, collected off *Onthophagus laminatus* Moll., and assigned dubiously three Australian specimens to *M. krantzi.* Wallace (1986) reported seven additional collections (ex *Onthophagus nodulifer* and *O. laminatus*) from Townsville and Ingham, northeastern Queensland, Australia. Anwarullah and Irshad (1971) described a new species of *Macrocheles* by the name *M. krantzi*. The description and illustrations of the species provided by them are quite dissimilar to those of *M. krantzi* of Evans and Hyatt and suggest a different species.

4. ***Macrocheles merdarius*** (Berlese, 1889)

Holostaspis merdarius Berlese, 1889, *Acari Myriapoda et Scorpiones* etc., 52 (1).

Macrocheles merdarius: Sellnick, 1940, *Goteborg, Vetensk. Samh. Handl.,* (5). 6(B) (14): 86.

Macrocheles merdarius: Evans and Browning, 1956, *Bull. Brit. Mus.* (*Nat. Hist.*) *Zool., (1)*: 21; Bregetova and Koroleva, 1960, *Parasit. Sbornik. Zool. Inst., 19*: 145; Filipponi and Pegazzan, 1963, *Redia, 48*: 83; Krauss, 1970. *Acarologie Sch. vergl. Milbenk, 14*: 17; Wallace, 1986, *Acarologia, 27(1)*: 9; not *Macrocheles merdarius* Bhattacharya, 1971, *Orient. Insects, 5*: 498 (misidentification);

Material examined: 2 females Arunachal Pradesh: Tirap dist. Deban, Chakma Bastee 12.i.1981 ex poultry litter; 1 female, Assam: Dibrugarh dist. Dibrugarh, Gosala, 7.vi.1979. ex dung heap; 1 female, Assam: Dibrugarh dist. Digboi, 4.iv.1976, ex dung heap, A.K. Dutta and R.K. Roy coll.; 3 females, Karnataka: Bangalore, Entomology Museum, University of Agricultural Sciences, ex *Copris* sp., coll. date and coll. unlisted; 1 female, Tamil Nadu: Chennai (Madras) Zoo Garden, lake area, 5.iii.1980, ex leaf litter; 7 females, Coimbatore, Tamil Nadu Agricultural University Campus, Central Diary Farm, 13.iii.1980, ex dung heap; 1 female, Uttar Pradesh: Allahabad dist. Mirapur, 13.xii.1977. ex rotten leaf litter, Y.N. Gupta coll.

Distribution: *M. merdarius* is a nearly cosmopolitan species. The following distribution records are known so far. It occurs widely in Europe: Italy (Berlese 1889, Filipponi and Pegazzano 1963, Rota and Serini 1976): Great Britain (Evans and Browning 1956, Hyatt 1956): USSR (Bregetova and Koroleva 1960); Hungary (Eröss and Mahunka 1971); Bulgaria (Balogh

1958); Central Europe (Leitner 1946, Franz 1954). Further records are from Australia (Wallace 1986), New Zealand (Emberson 1973); Kermadec Islands (Emberson 1980); North America (Chant 1960, Axtell 1961, 1963); Japan (Ishikawa 1968), Israel (Costa 1966) and India. Record of *M. merdarius* by Bhattacharya (1971) from Assam is a misidentification of *M. sikkimensis*, a new species described in part V of the series. Pramanik (1977) first recorded *M. merdarius* from West Bengal and has provided only measurements. The following are new records from India: Arunachal Pradesh, Assam, Karnataka, Tamil Nadu and Uttar Pradesh.

Remarks: The Indian material conforms to the descriptions and figures given by Evans and Browning (1956), Filipponi and Pegazzano (1963) and Bregetova and Koroleva (1960). Lateral margins smooth or incised.

5. *Macrocheles muscaedomesticae* (Scopoli)

Acarus muscaedomesticae Scopoli, 1772, *Annus V. Hist. Nat., 125*: 157.

Acarus marginatus Hermann, 1804, *Mem. Apt.*: 76.

Macrocheles muscaedomesticae Pereira and Castro, 1945, *Arq. Inst. Biol. S. Paulo, 16*: 153 Evans and Browning, 1956. *Bull.*

Brit. Mus. (Nat. Hist.) Zool., 4 (1) 12: Filipponi and Cervone, 1957, *Riv. Parass., 18*: 17; Bregetova and Koroleva, 1960, *Parassit. Sbornik, Zool. Inst., 19*: 131; Singh and Kapoor, 1976, *Ent. News., 87 (9-10)*: 292-294.

Material examined: 1 female, Assam: Nowgong dist. Lumding, 28.xii.1973, ex cowdung; 2 females, Dibrugarh dist. Dibrugarh, Gosala, 3.vi.1973, ex *Musca domestica* L.; 1 female, Orissa: Mayurbhanj dist. Katipada, 30.iii.1976, ex *Cyanopterus* sp. P.K. Das coll.; 1 female, Goa: Poinguinun, 26.xii.1979, ex *Cynopterus brachyotis ceylonensis* (Gray), V.C. Agarwal coll.

Distribution: *M. muscaedomesticae* is cosmopolitan in distribution. India: Assam (new record), Goa (new record), Jammu and Kahsmir, Orissa (new record), Punjab and West Bengal.

Remarks: In India, this species has been recorded as an associate of *Musca domestica* L. from Jammu and Kashmir (Sharma & Sharma 1973). Singh and Kapoor (1976) also reported *M. muscaedomesticae* as a palm squirrel (*Funambulus pennanti* Wroughton) associate in northern India. We have collected it from *Musca domestica* and from bats.

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A TAXONOMIC ACCOUNT OF *LUISIA* GAUD. (ORCHIDACEAE) FROM BANGLADESH[1]

Mokter Ahmed and M.K. Pasha[2]

(*With four text-figures*)

Key words: Taxonomy, *Luisia,* Orchidaceae, Bangladesh

The genus *Luisia* Gaud. of the family Orchidaceae is represented in Bangladesh by seven species, out of which *L. grovesii* Hk. f., *L. trichorhiza* Bl. and *L. zeylanica* Lindl. are recorded for the first time in Bangladesh. A key to the species has been given.

Introduction

The name *Luisia* was erected in honour of Don Luis de Torres, a Spanish botanist of the 19th century. The genus is closely allied to genus *Vanda* and the species are commonly known as Bee Orchids. The genus consists of about 30 species, distributed in Tropical Asia, Japan and Polynesia (Airy-Shaw 1973, Hunt and Grierson 1973). Hooker (1890) reported 13 species from British India. Grant (1895), Prain (1903) and Bruhl (1926) recorded five species each from Burma (Myanmar), Bengal and Sikkim respectively. Santapau and Kapadia (1966) and Banerji (1982) reported only three species from Bombay and Nepal respectively. On the other hand, at least 12 species have been reported by Bose and Bhattacharjee (1980) and seven species by Pradhan (1979) from India. Within the political boundaries of Bangladesh, four species (*L. teretifolia* Gaud.; *L. Brachystachys* Bl. Rumph.; *L. filiformis* Hk.f. and *L. volucris* Lindl.) were reported by Hooker (1890) from Sundarbans, Sylhet and Chittagong. Heinig (1925) and Sinclair (1955) reported *L. teretifolia* Gaud. and *L. volucris* Lindl. from Chittagong Hill Tracts and Collectorate, and Cox's Bazar, respectively. This work aims at studying the genus comprising seven species. including the earlier reported four species, along with three additional species viz. *L. grovesii* Hk. f., *L. trichorhiza* Bl. and *L. zeylanica* Lindl., recorded for the first time in Bangladesh.

The herbarium and live specimens are housed at the Botany Department and Orchidarium of Chittagong University, Chittagong, Bangladesh.

Key to the species of *Luisia*

1. Petals much longer than the sepals; lip usually 8-9 mm long 2
— Petals slightly longer than sepals; lip usually 6-7 mm long 3
2. Petals dilating to rounded tip .... *L. volucris*
— Petals not dilating to rounded tip .. *L. grovesii*
3. Dividing line between hypochile and epichile indistinct, the epichile not suddenly widening at base .... *L. brachystachys*
— Dividing line between hypochile and epichile distinct, the epichile suddenly widening at base 4
4. Leaves secund, long and thin *L. filiformis*
— Leaves not so 5
5. Epichile reniform without any distinguishable apex. .... *L. teretifolia*
— Epichile triangular - cordate 6
6. Epichile less than 5 mm long ...... *L. zeylanica*
— Epichile more than 5 mm long .... *L. trichorhiza*

1. ***Luisia volucris*** Lindl. Fol. Orch. 1, 1853; in Hk. f., Fl. Brit. Ind., 6: 25 (1890); Prain, Beng. Pl., 2: 765 (1903); Bruhl, Orch. Sikkim, 122 (1926); Pradhan, Ind. Orch., 2: 534 (1979).

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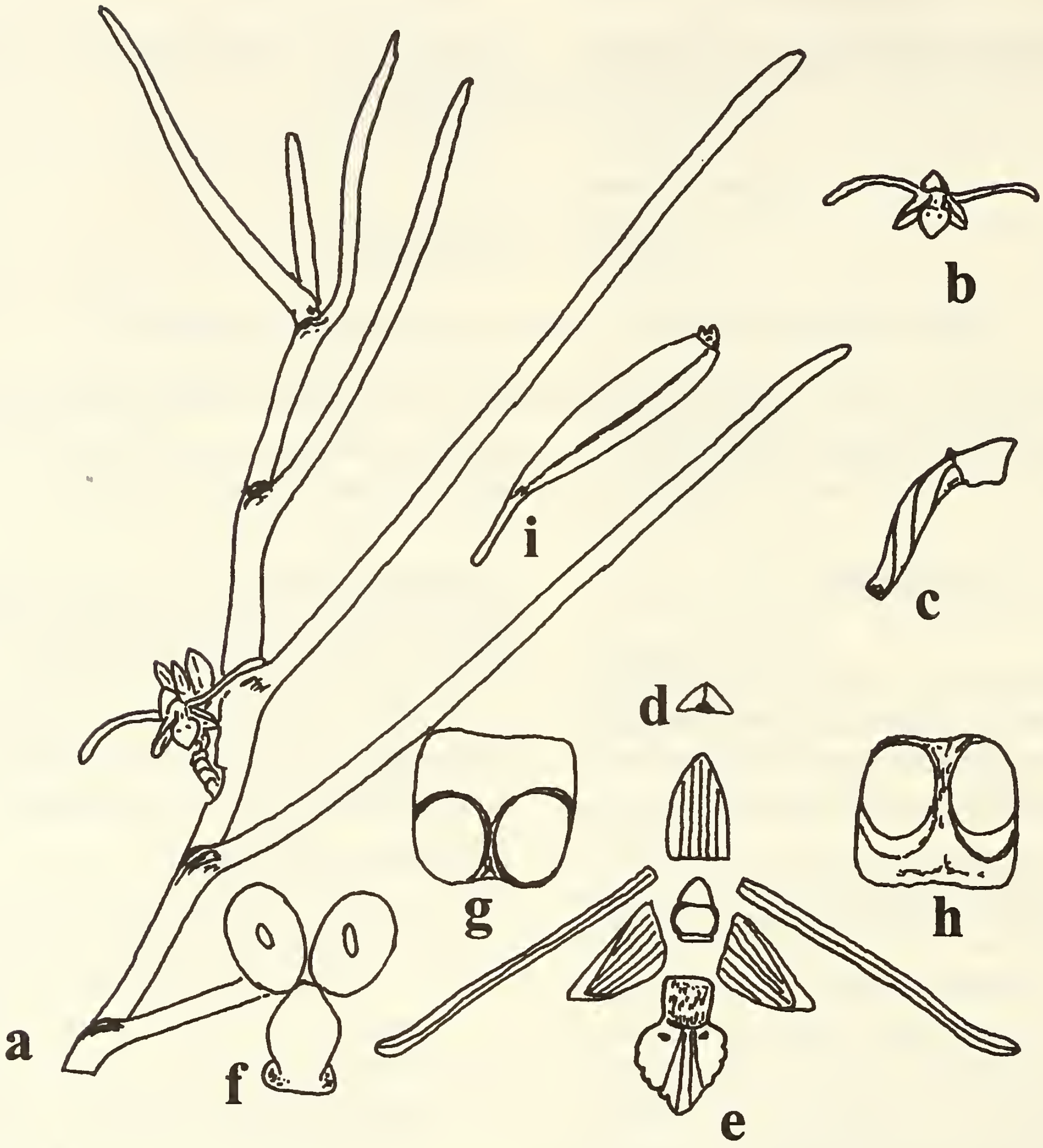

Fig. 1: *Luisia grovesii* Hk. f.: (a) habitat sketch (x 1); (b) flower from front (x 1); (c) pedicellate ovary with column from side (x 2); (d) floral bract (x 2); (e) sepals, petals and lip spread out, column from inside (x 2); (f) pollinia attached with strap (x 10); (g) operculum from front (x 10); (h) operculum from inside (x 10); (i) capsule (x 1). Diagram reduced by one-third

According to Hooker (1890) "the flowerless specimens closely resemble *L. teretifolia,* the drawing of the Chittagong plants. The stem is slender, the internodes are 3.0 cm and leaves 14.0 - 18.0 cm instead of 6.0 - 10.0 cm, the petals not dilated at the tip instead of dilating to the rounded tip, and the epichile of the lip green and grooved". On the other hand, specimens from Khasi and Jaintia Hills reported by Pradhan (1979) are linear, dilating to a rounded tip of petals.

Geographical distribution: Sikkim Himalaya, Khasi Hills., Sylhet and Chittagong.

Specimens examined: Sikkim, *J.D.H.*; Khasi Hills and Sylhet, Lobb., *J.D.H.* and T.T.; Chittagong, *Prain*.

2. ***Luisia grovesii*** Hk. f., Fl. Brit. Ind., 6: 25 (1890); Hooker, Cent. Ind. Orch., pt. 53, 35 (1895) (Fig. 1).

This species closely matches with Hooker's (1890) descriptions and Hooker's (1895) drawings. After critical study of the living specimens we also conclude that it is closely related to *L. filiformis* and *L. volucris* but at once distinguishable by the long petals with the former and having narrow linear-obtuse petals without dilated tip as in the latter.

Flowering scape initiation: Late February;

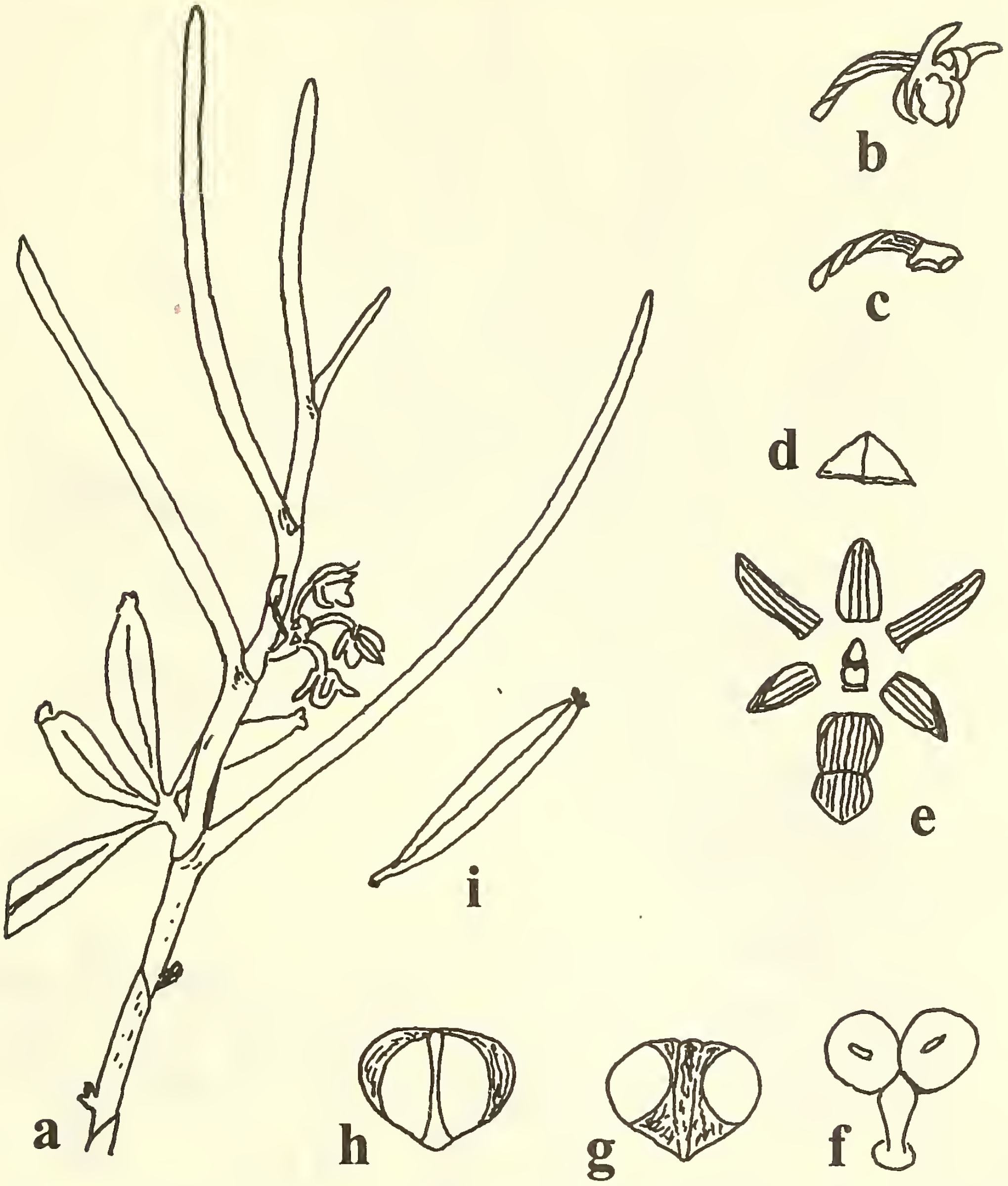

Fig. 2: *Luisia teretifolia* Gaud.: (a) habit sketch (x 1); (b) flower from - front (x 2); (c) pedicellate ovary with column from side (x 2); (d) floral bract (x 4); (e) sepals, petals and lip spreadout, column from inside (x 2); (f) pollinia attached with strap x 10); (g) operculum from front (x 10); (h) operculum from inside (x 10); (i) capsule (x 1). Diagram reduced by one-third

Flowering: Mid March - mid June; Fruiting : June onwards.

Geographical distribution: Eastern Bengal and Bangladesh.

Specimen examined: Cox's Bazar district: Ramu, Panerchara, 13.x.1986, *Mokter* 39.

3. ***Luisia brachystachys*** Bl., Rumphia, 4: 50, 1848; Hk. f., Fl. Brit. Ind., 6: 23(1890); Prain, Beng. Pl. 2: 765 (1903). Syn. Lindl., Fol. Orch. 3, 1853, *Mesoclastes brachystachys* Lindl., in Wall Cat., 1994.

Leaves 5.0-15.0 cm long, slender; sepals and petals as in *L. teretifolia* as the species observed by Hooker (1890). He also noted that it was a more slender plant than *L. teretifolia,* perhaps a variety.

Geographical distribution: Tropical Western Himalaya; Tenasserim; Khasi Hills; Northeastern Bangladesh.

Specimen examined: Garhwal, *Falconeri; Kumaon, Stewart;* Sylhet and Khasi Hills, *Wallich; Bengal, Clark;* Sundribuns, *Prain.*

4. ***Luisia filiformis*** Hk.f., Fl. Brit. Ind., 6: 23 (1890); Pradhan, Ind. Orch., 2: 537(1979); Bose and Bhattacharjee, Orch. Ind., 364 (1980).

According to Hooker (1890), the petals of this species are hardly longer than the sepal, except the short linear petals. This species

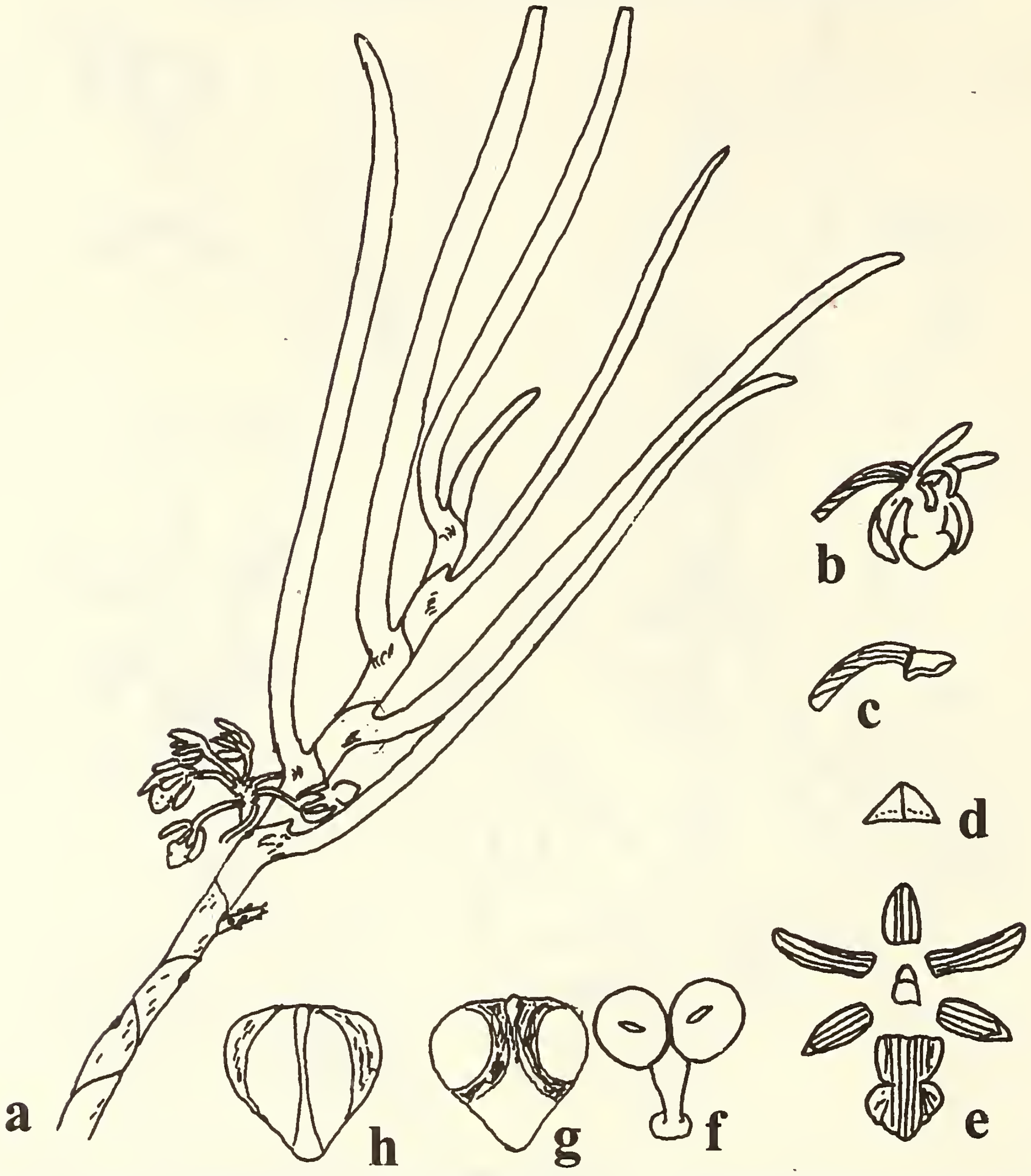

Fig. 3: *Luisia zeylanica* Lindl.: (a) habit sketch (x 1); (b) flower from + front (x 2); (c) pedicellate ovary with column from side (x 2); (d) floral bract (x 50); (e) sepals, petals and lip spreadout, column from inside (x 2); (f) pollinia attached with strap (x 10); (g) operculum from front (x 10); (h) operculum from inside (x 10). Diagram reduced by one-third

resembles *L. grovesii.* On the other hand Pradhan (1979) showed that the petals are equalling sepals at first but turn shorter and spathulate later on.

Geographical disribution: India, Sikkim, Myanmar, Thailand, Laos and Bangladesh.

Specimen examined: Sylhet, at Terrya Ghat, *Mann.*

5. ***Luisia teretifolia*** Gaud., Bot. Freye. Voy. 427, t. 37(1826); Hk. f., Fl. Brit. Ind., 6: 22(1890); Grant, Orch. Burma, 236 (1895); Prain, Beng. Pl., 2: 765 (1903); Heinig, Fl. Ctg. Hill Tracts and Coll., 1261 (1925); Bruhl, Orch. Sikkim, 123 (1926); Sinclair, Fl. Cox's Bazar, 108 (1955); Santapau and Kapadia, Orch. Bomb., 213 (1966) Bose and Bhattacharjee, Orch. of Ind. 366 (1980) Banerji, Orch. Nepal, 119 (1982). Syn. *Cymbidium triste* Roxb., Hort. Beng., 63 (1814), nom. nud.; *C. tenuifolium* Wight, Icon., 5: t. 1645 (1851); *Luisia truncata* Blatt. and McC *JBNHS 35*: t. 9, 491 (1932) (Fig. 2).

Hooker (1890) observed that the petals vary in length and form, but never much exceed the sepals. He noted that in five Indian drawings the lip is purple and in Griffith's figures it is shown as green with black purple blotches. On the other hand, Bruhl (1926) and Prain (1903) mentioned in their descriptions that the lip is purple,

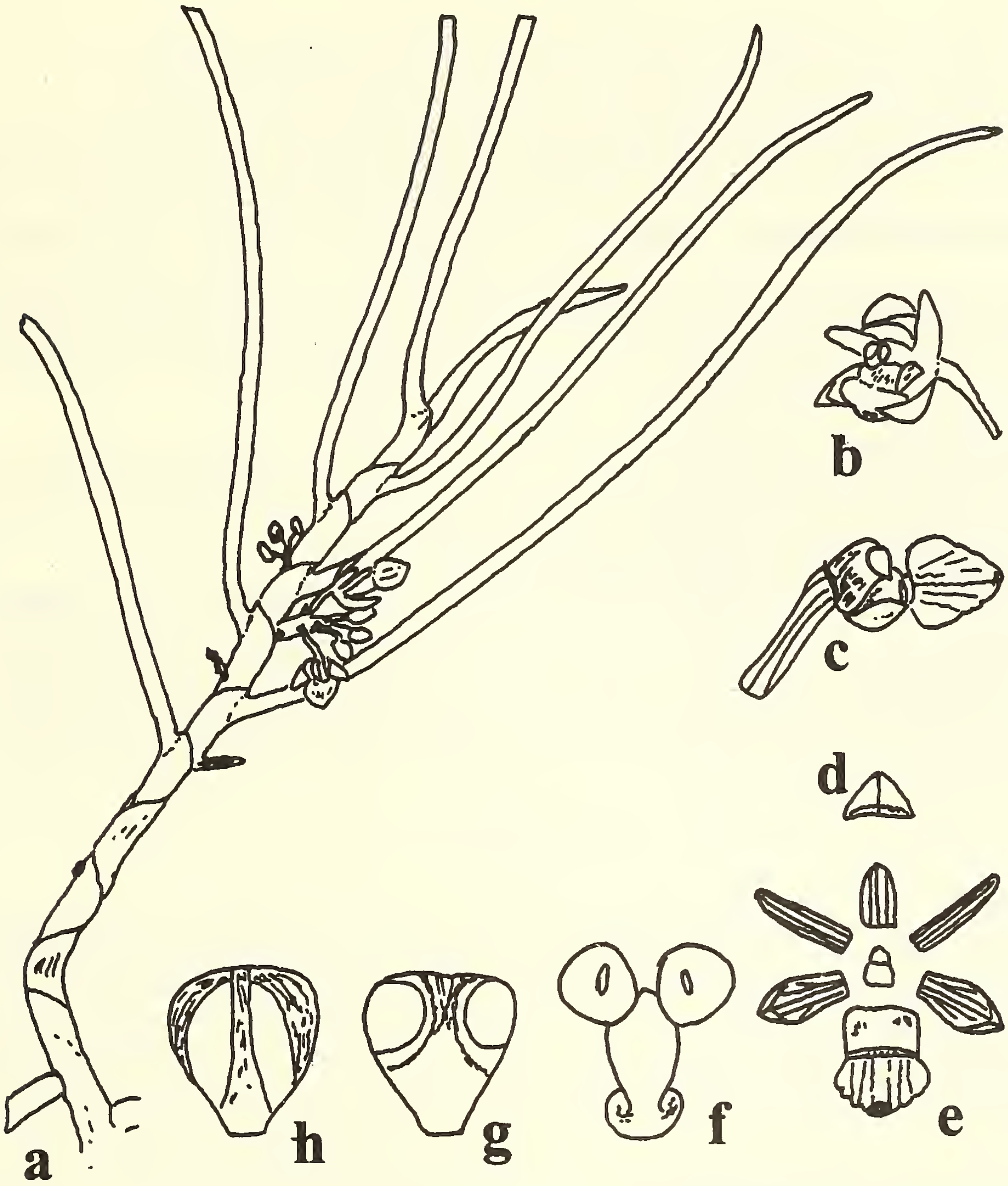

Fig. 4: *Luisia trichorhiza* Bl.: (a) habit sketch (x 1); (b) flower from + front (x 2); (c) pedicellate ovary, column and lip attached (x 3); (d) floral bract (x 3); (e) sepals, petals and lip spreadout, column from inside (x 2); (f) pollinia attached with strap (x 10); (g) operculum from front (x 10); (h) operculum from inside (x 10). Diagram reduced by one-third

rhomboid; sepals and petals green. Our specimens closely match with the latter. This species is very common and abundant, especially in the eastern part of Bangladesh.

Flowering scape initiation: Mid March; **Flowering**: Early April - mid May; **Fruiting**: May onwards.

Geographical distribution: Sri Lanka, India, Sikkim, Myanmar, Java, China and Bangladesh.

Specimens examined: Cox's Bazar district: Ukhia, Maricha Bazar, 11.x.1986 (Fruiting), *Mokter* 1(a); Ramu, Panerchara, 13.x.1986, *Mokter* 38; Tangail dist.: Baderbaith, Madhupur, 8.iii.1990, *Mokter* 171; Khulna dist.: Sunderbans, 22.vii.1990, *Mokter* 197.

6. ***Luisia zeylanica*** Lindl., Fol. Orch. 3, 1853; Pradhan, *In*: Ind. Orch., 2: 537 (1979). (Fig. 3)

This species is allied to *L. teretifolia,* but differs in having the lip deep purple; epichile ± dentate, deflexed, cordate-triangular and having larger flowers. Our specimen closely resembles Pradhan's description. It was found fruitless in the natural habitat as well as in the Orchidarium, whereas fruiting was commonly observed in *L. teretifolia*.

Flowering scape initiation: Late February;

Flowering: Mid March-mid June; **Fruiting**: Unknown.

Geographical distribution: Southeast Asia.

Specimen examined: Cox's Bazar district: Maricha Bazar, 11.x.1986, *Mokter* 1(b).

7. ***L. trichorhiza*** Bl., Rhumphia, 4: 50 (1848); Hk. f., Fl. Brit. Ind., 6: 23 (1890); Duthie, Fl. Upp. Gang. Pl., 3: 206 (1920); Pradhan, Ind. Orch., 2: 538 (1979); Bose and Bhattacharjee, Orch. Ind., 368 (1980); Banerji, Orch. Nepal, 119 (1982) (Fig. 4).

According to Hooker (1890) the flowers of this species are twice as large as in *L. teretifolia*. Our living specimen closely resembles the description and drawings of Pradhan (1979). Bruhl (1926) noted that the species is epiphytic on sal trees in Dehradun (Gamble, Mackinnon). Our specimen was found to grow on the trunk of a rain tree (*Samanea saman*) in Lama Bazar of Sylhet dist.

Flowering scape initiation: Early March; **Flowering**: Late March - mid May; **Fruiting**: Unknown.

Geographical distribution: India, Sikkim, Myanmar, Thailand and Bangladesh.

Specimen examined: Sylhet district: Lama Bazar, 21.iii.1986 (Flowering), *Mokter* 102.

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NEW DESCRIPTIONS

A NEW SPECIES OF *MACROCENTRUS* CURTIS (HYMENOPTERA: BRACONIDAE) FROM INDIA[1]

S.M. Kurhade[2] and P.K. Nikam[3]

(*With three text-figures*)

Macrocentrus nixoni sp. nov. is described and illustrated. A key to the Indian species of *Macrocentrus* Curtis is provided.

Introduction

Macrocentrus Curtis is a small genus erected with a type species, *Macrocentrus bicolor* Curtis. Muesebeck (1932) and Eady and Clark (1964) revised the genus. Shenefelt (1969) contributed on the taxonomy of *Macrocentrus.*

In India, only three species of *Macrocentrus* Curtis are known so far, *viz., M. crassinervis* Nixon (1950), *M. persephone* Nixon (1950) and *M. trimaculatus* (Cameron) Nixon (1939).

In the present work *Macrocentrus nixoni* sp. nov. is described from the material collected in India: Maharashtra: Ahmednagar and a key to the Indian species of *Macrocentrus* Curtis is provided.

Types* have been deposited in the Entomological collection of Department of Zoology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.

Key to the Indian species of *Macrocentrus* Curtis

1. Body ivory white 4
— Body yellowish-red, brownish to dark brown; face punctate 2
2. Propodeum evenly rugose all over; first tergite finely, transversely striate; tergite 3 without sculpture .... *trimaculatus* (Cameron) Nixon, 1939
— Propodeum differently sculptured; tergite not transversely striate; tergite 3 sculptured 3
3. Propodeum reticulately rugose; mesopleurum finely punctate; tergite 1 and (2+3) finely, longitudinally striate all over; ovipositor as long as body .... *persephone* Nixon, 1950
— Propodeum with mid transverse carina, basally longitudinally strigose; tergite 1 reticulately strigose, shallowly punctate; tergites (2+3) striate throughout; ovipositor slightly longer than body .... *nixoni* sp. nov.
4. Face smooth; propodeum with faint scaly reticulation and traces of transverse striations; mesopleurum shining, punctures indistinct; tergite 1 shining, with faint traces of longitudinal aciculation; ovipositor sheath as long has abdomen plus the propodeum .... *crassinervis* Nixon, 1950

Macrocentrus nixoni sp. nov.
(Figs. 1-3)

Female: Length 4.9 mm. (Fig. 1). Head (Fig. 2) transverse, 2.4 times as wide as long; vertex smooth, with pubescence; interorbital space 0.2 times the width of head; frons moderately punctate, pubescent; face 1.45 times as wide as long, convex, with sparse punctures, pubescent; mandible 2.2 times as long as wide at base, bidentate, with tuft of bristles from outer side; antenna 2 + 45 segmented, finely pubescent throughout the length; scape 2.4 times as long as wide, finely pubescent; pedicel as long as wide; post pedicel 7.3 times as long as wide; penultimate segment 0.6 times the length of terminal segment; malar space as long as basal width of mandible;

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*Serial No. of the type specimens deposited at Dr. B.A. Marathwada University, Aurangabad is BR MCR1/MUZ/SMK2.

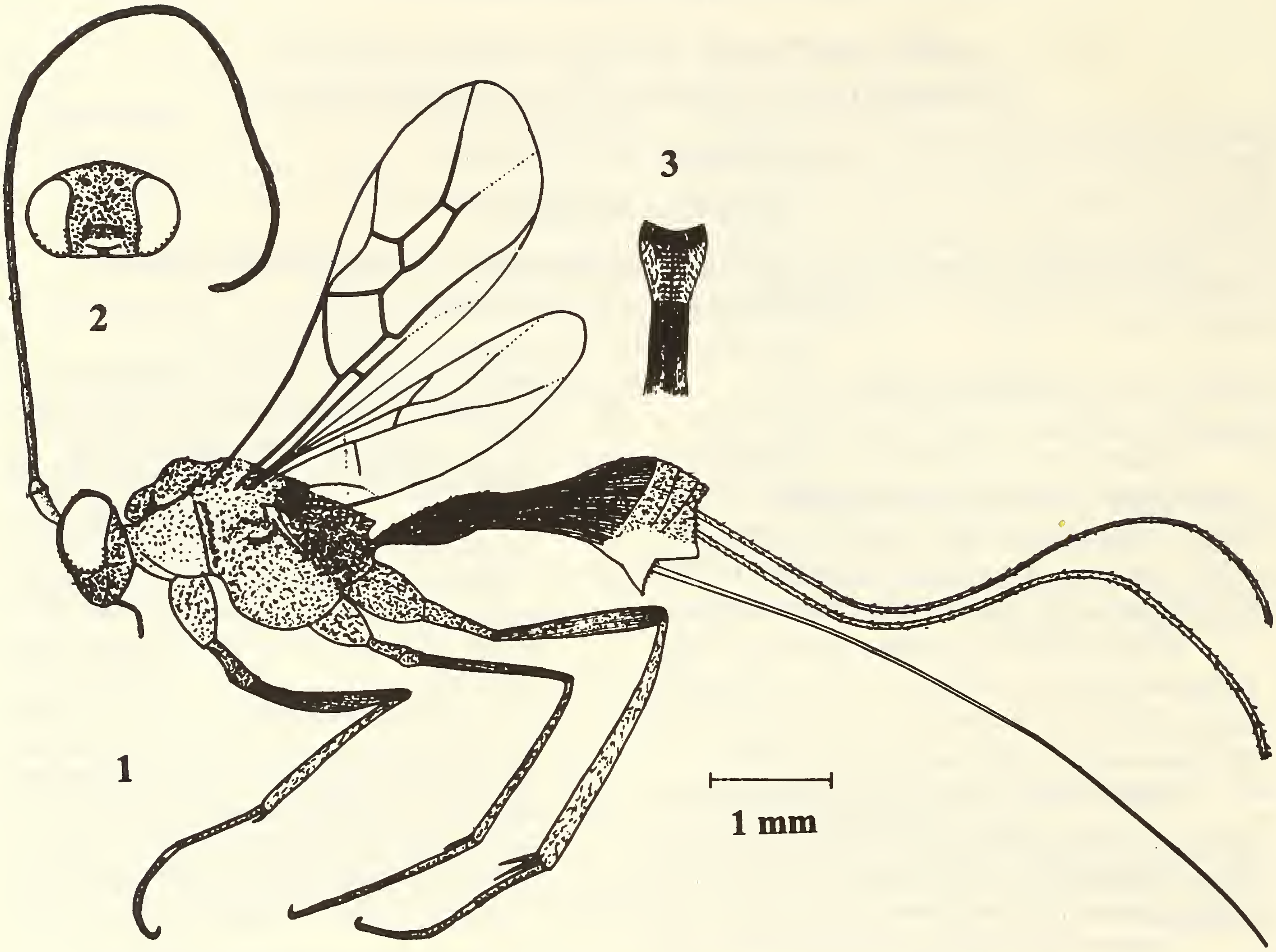

Fig. 1-3: *Macrocentrus nixoni* sp. Nov. (Female). 1. Adult lateral view; 2. Head, frontal view; 3. Propodeum, with first abdominal tergite.

eye bare, 1.8 times as long as wide; maxillary palp very long; occipital carina absent.

Thorax: 2.5 times as long as wide; pronotum shiny, pubescent, its posterior margin carinated; mesoscutum smooth, sparsely, shallowly punctate, sparsely pubescent; notauli distinct, complete; scutellum shiny, weakly, shallowly punctate, finely pubescent, without any carina; postscutellum small, shiny; mesopleurum not polished, weakly punctate, pubescent; prepectal carina distinct; mesopleural furrow distinct, extending to the length of mesopleurum; mesopleural fovea distinct; metapleurum rugose, punctate, pubescent; submetapleural carina distinct; propodeum (Fig. 3) with mid transverse carina, basally longitudinally strigose, basal longitudinal carina extending to the tip, pubescent; propodeal spiracle round. Hind leg coxa long, 4 times as long as wide, moderately punctate on outer side, striate on inner side, pubescent; trochanter long; first trochanter 3.3 times as long as wide, moderately, shallowly punctate, pubescent; femur 8 times as long as wide, 1.5 times as long as coxa, weakly striate, moderately, shallowly punctate, pubescent; tibial spur 0.4 times the length of basitarsus; tibia 0.35 times the length of femur, 16.5 times as long as its own apical width, aciculate, moderately punctate, pubescent; basitarsus 0.35 times the length of tibia; second tarsomere 0.4 times the length of basitarsus; claw simple, bifid. Forewing 3.15 times as long as broad; stigma 4.1 times as long as wide; metacarpus 1.45 times as long as stigma; first abscissa of radius 0.5 times the length of second abscissa; second abscissa of radius 1.9 times as long as first abscissa; third abscissa of radius 4.2 times as long as first abscissa; three cubital cells present; second cubital cell with four unequal sides; cubitus 2.25 times as long as stigma, not sclerotised throughout the length; medius 0.6 times the length of costa; basal 0.6 times the length of medius; nervulus slightly reclivous, distad, 0.6 times the width of stigma; subdiscoideus 1.9 times as long as stigma; anal cell 23.7 times as long as wide, with four marginal bristles. Hind wing 4.4 times as long as broad; nervellus inclivous, basal 0.45 times the length of submediella; basella 0.15 times the length of mediella, sclerotized; subcostella 1.4 times as long as mediella; post-nervellus absent.

Abdomen: 3.5 times as long as wide — long, wide medially; first tergite 2 times as wide apically as basally, 3.5 times as long as basal width, strigoso-reticulate, shallowly punctate, pubescent; suture between first and second tergites distinct; second tergite fused with third; tergite (2 + 3) 1.8 times as long as wide apically, striate throughout the length, weakly punctate, pubescent; fourth tergite 0.3 times the basal width, moderately punctate, pubescent; fifth tergite 0.4 times the basal width, moderately punctate, pubescent; sixth tergite 0.3 times its own width, conical, moderately punctate, pubescent; seventh tergite slightly visible; ovipositor slightly longer than the body length; ovipositor sheath as long as ovipositor, with bristles throughout the length.

Colour: yellowish-red. Antenna, ovipositor sheath brownish-black; stigma, veins and ovipositor reddish-brown; tip of mandibles and oblong spot on frons blackish.

Male: Unknown.

Holotype: Female: INDIA: Maharashtra: Ahmednagar, 20. x. 1990, on wing, coll. S.M. Kurhade; Antenna, wings and legs mounted on slides and labelled as above.

Paratypes: 4 females, data same as holotype.

Etymology: The species has been named *nixoni* in honour of Dr. G.E.J. Nixon, a well known taxonomist on Braconidae.

Comments: In the key to the Indian species of *Macrocentrus* Curtis cited above, the new species *Macrocentrus nixoni* resembles *Macrocentrus persephone* Nixon (1950) in the key characters. However, it differs from the same in the following characters: (i) antenna 2 + 45 segmented, (ii) propodeum with mid transverse carina, basally longitudinally strigose, (iii) mesopleurum weakly punctate, (iv) first tergite strigoso-reticulate, shallowly punctate and (v) ovipositor slightly longer than body.

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* Original not referred to.

A NEW GENUS OF ALLANTINAE FROM INDIA (HYMENOPTERA: SYMPHYTA: TENTHREDINIDAE)[1]

Malkiat S. Saini and V. Vasu[2]

(*With eighteen text-figures*)

Key words: *Anisotaxonus* gen. nov., Allantinae, Hymenoptera, India.

Described as a new genus belonging to subfamily Allantinae from India, *Anisotaxonus* is based on three new species. This genus is closely allied to the genus *Taxonus* Hartig (1837), from which it differs in several significant characters.

INTRODUCTION

All three new species described under the new genus *Anisotaxonus*, run smoothly in Malaise's (1963) key upto couplets 92 and 132, where these can be wrongly associated with the genus *Taxonus* Hartig or *Parasiobla* Ashmead. However, when seen in detail they clearly differ from *Parasiobla* and *Taxonus,* on the basis of some stable and reliable characters such as: extent and shape of clypeal incision; ratio of antennal segments 3 and 4; overall shape of antenna; presence or absence of postgenal as well as postorbital carinae; presence or absence of punctures on mesopleura; presence or absence of closed middle cell in hind wing; general direction and angle of anal cross vein in forewing. These three species can be grouped under the new genus *Anisotaxonus*.

Type material is deposited at Indian Agricultural Research Institute, Pusa National Collections, Division of Entomology, New Delhi, India.

Abbreviations used in text are: IATS = Inner apical tibial spur, ICD = Intercenchri distance, IDMO = Interocular distance at level of median ocellus, ITD = Intertegular distance, LID = Lower interocular distance, MB = Metabasitarsus, OATS = Outer apical tibial spur, OCL = Ocello-occipital line, OOL = Oculo-ocellar line, POL = Postocellar line.

Anisotaxonus gen. nov.
(Figs. 1, 2, 6, 7)

Adult: Antenna (Figs. 6-7) 9 segmented; scape longer than pedicel; segment 3 shorter than 4; some apical segments may be compressed. Circular clypeal incision at the most upto half of its medial length. Labrum broader than long with rounded anterior margin. Postgenal carina absent; hind orbits not carinated. Mesopleuron smooth, shining and impunctate. Metabasitarsus shorter than following joints combined. Claw with a subapical tooth and with or without basal lobe. Forewing (Fig. 1) with veins M and Rs+M meeting Sc+R at or near the same point, but the distance is less than the length of first cubital cross vein; anal cross vein oblique. Hindwing (Fig. 2) with one closed middle cell; anellan cell petiolate.

Type species: ***Anisotaxonus brunneus*** sp. nov.

Distribution: INDIA.

Discussion: *Anisotaxonus* gen. nov. is allied to *Taxonus* Hartig on the basis of some characters such as: circular incision of clypeus; scape longer than pedicel; mesopleura smooth,

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shining and impunctate; anal cross vein oblique and hindwing with closed middle cell. However, the new genus differs from *Taxonus* on the basis of some other significant characters, such as: some apical antennal segments compressed; segment 3 shorter than 4; clypeal incision at the most upto half of its medial length; postgenal carina absent; hind orbits not carinated. Otherwise all the species of the new genus can be wrongly keyed under *Parasiobla,* a genus that was erected by Ashmead (1898) with *Taxonus rufocinctus* Norton as its type species, but suppressed into synonymy of *Taxonus* by Konow (1905) and again revived by Malaise (1963) on the basis of the absence of closed middle cells in the hindwing, a character which is especially variable in *rufocinctus,* its type species. We agree with Smith's (1979) arguments that the criteria used by Malaise (1963) to divide *Taxonus* Hartig into four genera: *Taxonus, Strongylogastroidea, Hypotaxonus,* and *Parasiobla* (= *Polytaxonus*) on the basis of variable, unstable and very weak characters, such as the comparative length of hind basitarsus and presence or absence of closed middle cell in the hind wing, are completely unreliable and thus unacceptable. Thus, we consider all of them as synonyms of *Taxonus* Hartig (1837). Because of the differences enumerated above, a new generic name is proposed to accomodate the new species.

Etymology: The generic name is based on its remarkable distinction from the genus *Taxonus* Hartig (Aniso= dissimilar or not same), and feminine form is used.

KEY TO THE SPECIES OF *ANISOTAXONUS* FROM INDIA

1. Abdomen auratus with black markings; antenna unicolour, uniformly black; tarsal claw without basal lobe; malar space at the most 1x diameter of median ocellus 2

— Abdomen entirely fuscoferruginous; antenna bicoloured, tip auratus; tarsal claw with distinct basal lobe; malar space distinctly longer than diameter of median ocellus .... *A. brunneus* sp. nov.

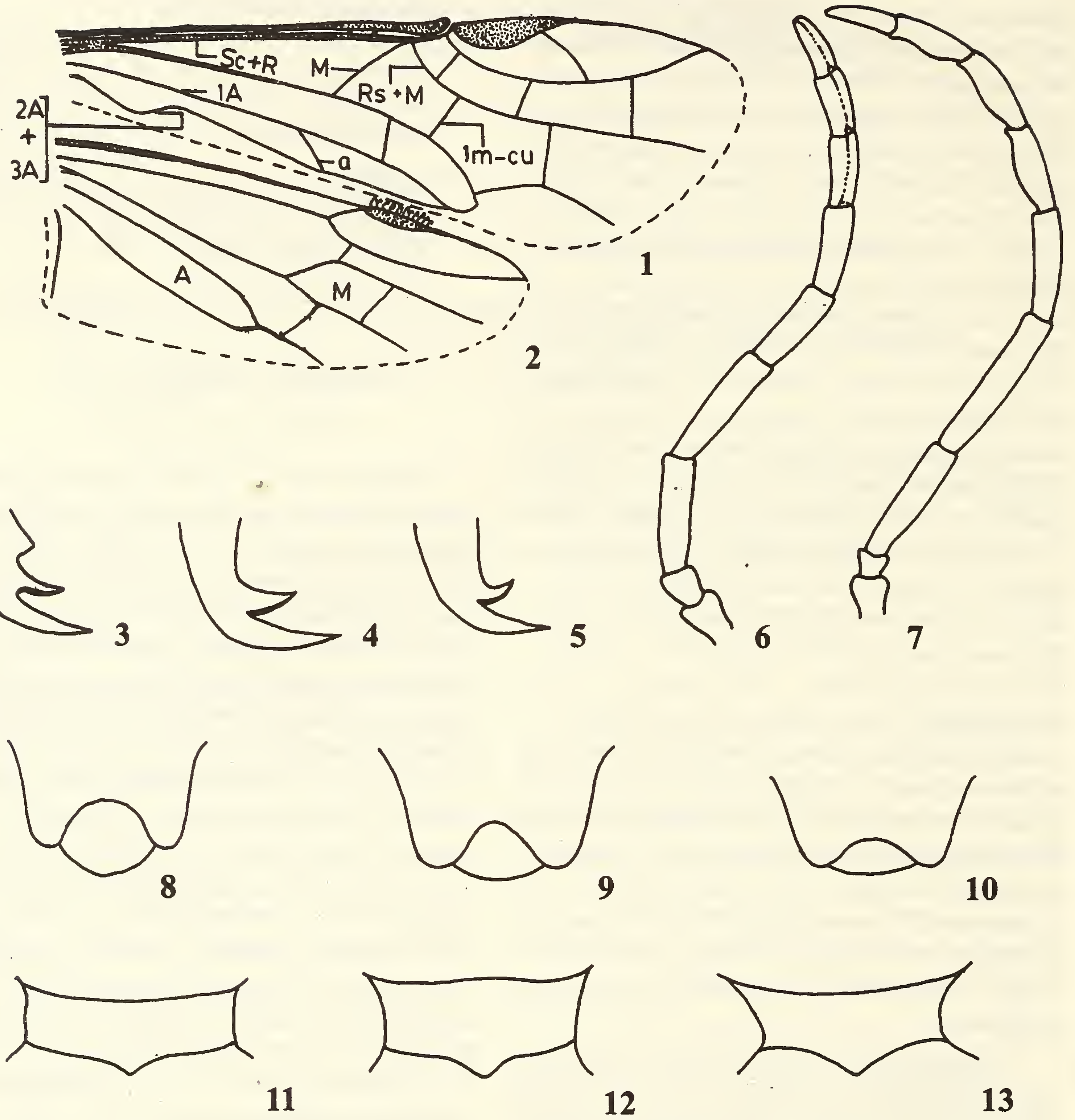
2. Malar space 1x diameter of median ocellus; postocellar area as long as broad; antennal segments 3 and 4 as 2:3; OOL:POL:OCL = 5:4:5 .... *A. sessaensis* sp. nov.

— Malar space 0.75 x diameter of median ocellus; postocellar area broader than long as 4:3; antennal segments 3 and 4 as 3:4; OOL:POL:OCL = 6:4:5 .... *A. assamensis* sp. nov.

Anisotaxonus brunneus sp. nov.
(Figs. 3, 6, 8, 11, 14)

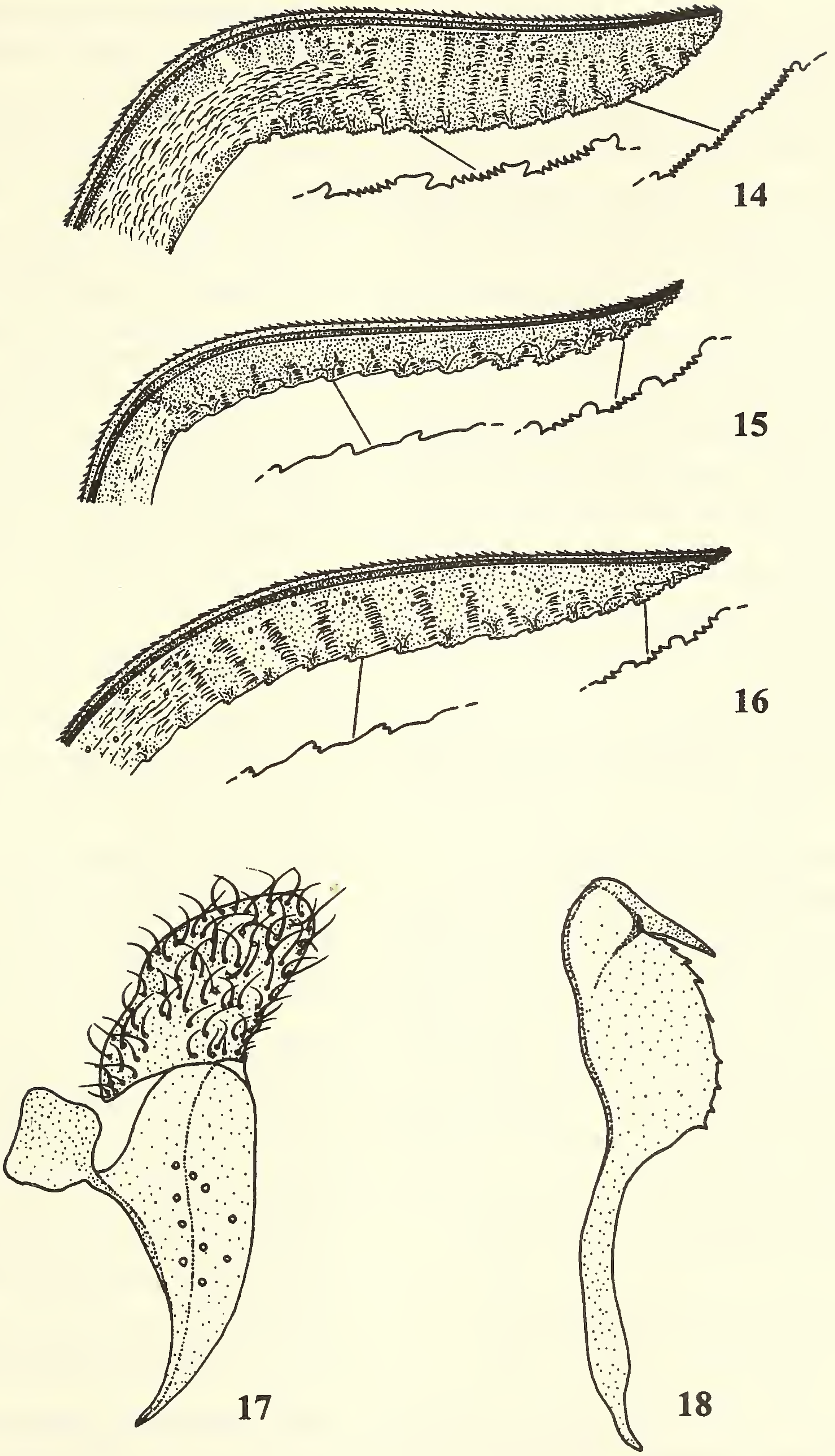
Female: Colour: Head fuscoferruginous, whitish yellow are: extreme apical tip of antennal segment 6; segments 7-9 entirely; clypeus; labrum; supraclypeal area; broad inner orbit; lower 1/3 of hind orbit. Black are: antenna except whitish yellow segments; supraclypeal pit; a broad spot on frontal area limited between frontal ridges and posteriorly covering ocellar region and extending upto hypothetical hind margin of head in the form of a narrow streak along lateral furrows. Thorax black, whitish yellow are: broad posterodorsal and narrow posterolateral margins of pronotum; tegula; sagittated apex of mesonotal middle lobe; mesoscutellum except its fuscoferruginous posterior margin; appendage; parapterum; a broad transverse spot on mesopleuron; a transverse stripe in lower half of mesepisternum extending upto coxal rim; most of metepisternum. Abdomen fuscoferruginous. Legs fuscoferruginous except coxae, trochanters and basal 1/3 of femora of all legs which are whitish yellow. Wings hyaline; extreme apices of costa and subcosta, basal 1/3 of stigma fulvous; rest of venation piceous.

Structure: Length 5.5 mm. Antenna (Fig. 6) long, 3.4 x head width, three apical segments distinctly compressed; scape 2x its apical width, pedicel 2x its apical width; segment 3 shorter than 4 as 6:7; clypeus (Fig. 8) circularly incised upto 1/2 of its length; labrum (Fig. 8) broader than long as 3:2, with slightly deflexed rounded



Figs. 1-2. *Anisotaxonus brunneus* Wings: 1. Forewing, 2. Hindwing; Figs. 3-5. Tarsal claw: 3. *A. brunneus*; 4. *A. sessaensis* 5. *A. assamensis;* Figs. 6-7. Antenna: 6. *A. brunneus;* 7. *A. sessaensis;* Figs. 8-10. Clypeus & Labrum: 8. *A. brunneus;* 9. *A. sessaensis,* 10. *A. assamensis;* Figs. 11-13. Hypopygium: 11. *A. brunneus;* 12. *A. sessaensis;* 13. *A. assamensis*

anterior margin; malar space 1.7x diameter of median ocellus; lower margin of eye below level of antennal socket; LID:IDMO:EL = 12:7:13; supraclypeal and supraantennal pits well marked; frontal area above level of eyes; supraantennal tubercles and frontal ridges insignificant; median fovea shallow with a distinct ditch in its anterior half only; post-, inter- and circumocellar furrows distinct; lateral furrows shallow, excurved (bulging) and abruptly ending well before hypothetical hind margin of head; postocellar area almost subconvex, broader than long as 3:2;



Figs. 14-16. Lancet: 14. *Anisotaxonus brunneus*, 15. *A. sessaensis*, 16. *A. assamensis*;
Figs. 17-18. Male genitalia: 17. Gonoforceps of *A. sessaensis*, 18. Penis valve of *A. sessaensis*.

head parallel behind eyes; OOL:POL:OCL = 5:4:5; mesoscutellum almost flat, appendage not carinate; ICD:ITD = 2:7; tarsal claw (Fig. 6) with a subapical tooth shorter than apical one and a distinct basal lobe, the distance between the two tips shorter than the length of subapical tooth; metabasitarsus shorter than following joints combined as 8:9; IATS:MB:OATS = 1:4:2. Lancet (Fig. 14) having 15 serrulae. Hypopygium as in Fig. 11.

Sculpture and pubescence: Head with dense, minute, fine punctures on frontal area, surface shining; mesonotum punctured like head, surface shining; mesoscutellum with dense minute, fine, irregular punctures on its posterior slope, surface shining; appendage shining; mesopleuron smooth, shining and impunctate with general oily lustre; abdomen impunctate, shining. Body covered with reddish to dark brown pubescence.

Male: Unknown.

Material examined: *Holotype*: Female, Manipur, Ukhrul, 1700 m, 24.v.1993, Coll. V. Vasu.

Distribution: INDIA: Manipur.

Diagnosis: *A. brunneus* is unique in having a combination of some significant characters such as: bicoloured antenna; fuscoferruginous abdomen; lateral furrows excurved; clypeus circularly incised upto 1/2 of its medial length; head parallel behind eyes and metabasitarsus shorter than following joints combined, which sets this species far apart from the rest of the species under this genus.

Etymology: Species name pertains to general colour of body.

Anisotaxonus sessaensis sp. nov.

(Figs. 4, 7, 9, 12, 15, 17, 18)

Female: Colour: Body black, auratus are: clypeus; labrum; mandible barring apex; broad inner orbit; lower hind orbit; tegula; spot on mesoscutellum; minute spots on the inner sides of mesonotal lateral lobes meeting in the centre; parapterum; a broad transverse spot on lower half of mesepisternum; spot on metapleuron; tergite 2 more or less; tergites 3-5 entirely; deflexed lateral sides of tergites 4-8; all sternites; all legs except apical 3 tarsi which are fuscoferruginous. Wings hyaline, venation including costa, subcosta and stigma piceous.

Structure: Average length 5 mm. Antenna (Fig. 7) long, 3.4 x head width, apical segments not compressed; scape 2x its apical width; pedicel 1.3x its apical width; segment 3 shorter than 4 as 2:3; clypeus (Fig. 9) with triangularly incised anterior margin upto 1/2 of its medial length; labrum (Fig. 9) broader than long as 2:1, with deflexed rounded anterior margin; malar space 1x diameter of median ocellus; lower margin of eye below level of antennal socket; LID:IDMO:EL = 2:2:1; supraclypeal and supraantennal pits well marked; frontal area slightly above level of eyes; supraantennal tubercles and frontal ridges insignificant; median fovea with a deep ditch in its anterior half and posteriorly only shallowly reaching median ocellus; post-, inter- and circumocellar furrows distinct; lateral furrows deep, distinct, parallel and abruptly ending just before hypothetical hind margin of head; postocellar area subconvex, broader than long as 4:3; head slightly narrowing behind eyes; OOL:POL:OCL = 5:4:5; mesoscutellum almost flat, appendage not carinate; ICD:ITD = 1:4; tarsal claw (Fig. 4) with a subapical tooth shorter than apical one and without basal lobe, the distance between the two tips equal to the length of subapical tooth; metabasitarsus shorter than following joints combined as 8:9; IATS:MB:OATS = 5:14:6. Lancet (Fig. 15) having 14 serrulae. Hypopygium as in Fig. 12.

Sculpture and pubescence: Head with a few fine, scattered punctures on frontal area, surface shining; thorax impunctate, shining with general oily lustre abdomen impunctate, shining. Body covered with mixed brownish and silvery pubescence except for the auratus part where it appears to be golden.

Male: Length 4 mm. Similar to female. Genitalia: Penis valve (Fig. 18), gonoforceps (Fig. 17).

Material examined: *Holotype*: Female, Arunachal Pradesh, Sessa, 1100 m, 23.v.1993, Coll. M.S. Saini. *Paratypes*: 1 Female, Arunachal Pradesh, Lazu, 1800 m, 5.v.1994, Coll. V. Vasu. 1 Female, 1 Male, Nagaland, Pfutsero, 2100 m, 14.v.1994, Coll. V. Vasu.

Distribution: INDIA: Arunachal Pradesh.

Diagnosis: *A. sessaensis* differs from all other known species of this genus in the following combined characters: antenna unicolour; abdomen partly black; incision of clypeus extending to 1/3 of its medial length; lateral furrows parallel; head narrowing behind eyes and presence of minute indistinct basal lobe.

Etymology: Species name is after its type locality.

Anisotaxonus assamensis sp. nov.
(Figs. 5, 10, 13, 16)

Female: Colour: Body black, whitish yellow are: clypeus except extreme base; labrum; mandible barring apex; a squarish spot on supraclypeal area; narrow inner orbit, tegula; inner margins of mesonotal lateral lobes meeting in the centre in front of mesoscutellum; top of mesoscutellum; parapterum; a broad spot on posteroventral margin of mesepisternum; most of metapleuron; all coxae, trochanters and the adjoining parts of all femora. Auratus are: scape; tergites 2-5; tergite 6 more or less; deflexed lateral sides of tergite 7; sternites 2-6; all femora; tibiae of front four legs; tarsi of proleg; rest of parts of all legs fuscoferruginous. Wings hyaline; venation including costa; subcosta and stigma piceous.

Structure: Length 5 mm. Antenna long, 3x head width, apical segments not compressed; scape 1.3x its apical width; pedicel as long as its apical width; segment 3 shorter than 4 as 3:4; clypeus (Fig. 10) circularly incised upto 1/3 of its medial length; labrum (Fig. 10) broader than long as 3:2, with deflexed rounded anterior margin; malar space 0.75x diameter of median ocellus; lower margin or eye below level of antennal socket; LID:IDMO:EL = 6:7:4; supraclypeal and supraantenal pits well marked; frontal area almost at level of eyes, supraantennal tubercles and frontal ridges insignificant; median fovea in the form of a ditch in its anterior half and posteriorly only shallowly reaching median ocellus; post-, inter- and circumocellar furrows shallow; lateral furrows deep, distinct, parallel and abruptly ending just before hypothetical hind margin of head; postocellar area subconvex, broader than long as 4:3; head narrowing behind eyes; OOL:POL:OCL = 6:4:5; mesoscutellum almost flat, appendage not carinate; ICD:ITD = 1:4; tarsal claw (Fig. 5) with a subapical tooth shorter than apical one and without basal lobe, the distance between the two tips is greater than the length of subapical tooth; metabasitarsus shorter than following joints combined as 8:9; IATS:MB:OATS = 4:8:3. Lancet (Fig. 16) having 16 serrulae. Hypopygium as in Fig. 13.

Sculpture and pubescence: Head, thorax and abdomen impunctate, smooth and shining with general oily lustre. Body covered with silvery pubescence except for auratus parts where it appears to be golden.

Male: Unknown.

Material examined: *Holotype*: Female, Assam, Jatinga, 800 m, 7.v.1993, Coll. V. Vasu. *Paratype*: 1 Female, Arunachal Pradesh, Tissa, 700 m, 7.v.1994, Coll. V. Vasu.

Distribution: INDIA: Assam.

Diagnostic combination: *A. assamensis* is closely allied to *A. sessaensis* but can be separated from it and other species of this genus on the basis of some remarkable characters such as colour pattern of body; length of malar space; clypeal incision; absence of basal lobe; ratio of antennal segments and postocellar area.

Etymology: Species name pertains to Assam state in which its type locality is situated.

ACKNOWLEDGEMENTS

We are deeply grateful to Dr. D.R. Smith of Systematic Entomology Laboratory, USNM, USA, for his valuable suggestions. Financial assistance rendered by US, PL - 480 in collaboration with ICAR is also gratefully acknowledged.

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A NEW SPECIES OF *OPHIORRHIZA* L. (RUBIACEAE) FROM KERALA, INDIA[1]

A.E. Shanavas Khan, E.S. Santhosh Kumar and P. Pushpangadan[2]

(*With six text-figures*)

A new species of *Ophiorrhiza* L. viz. *O. shendurunii* is described and illustrated.

During recent floristic studies conducted along the southern Western Ghats, we collected specimens of an interesting species of *Ophiorrhiza* L. On critical study it was found to be a new species. Hence it is described and illustrated here.

Ophiorrhiza shendurunii sp. nov.

(Figs. 1-6)

Peraffinis *O. eriantha* Wt. a qua differt neris lateralia in folia pauca, inflorescentes pubescentes, bracta et bracteola glabra, corolla pubescentes ad super basim, papillata sursum inferiora et capsula pilosa.

Typus: INDIA: Kerala, Kollam dist., Pandimotta *c* 1180 m, 27.i.1995 Coll. E.S. Santhosh Kumar 23271 (HOLO. TBGT; ISO. MH, CALI, K).

Allied to *Ophiorrhiza eriantha* Wt. but differs in having fewer lateral nerves in the leaves, pubescent inflorescence, glabrous bracts and bracteoles, corolla hairy above the base and then papillate upwards within, and pilose capsules.

Undershrubs; stem erect, branched, terete and glabrous; internodes 7-10 cm long. Leaves 8-12 x 3-5 cm, ovate to elliptic lanceolate, membraneous, glabrous, acuminate at the apex, attenuate at the base, with lateral nerves upto 10 pairs; petioles 1-3 cm long, glabrous; stipules interpetiolar, to *c.* 2 cm long, linear, broadened at the base and entire; inflorescence terminal, corymbose of helicoid cymes; peduncles pubescent; pedicels 0.1-0.2 cm long, pubescent; bracts and bracteoles many, linear, glabrous. Calyx tube terete, pubescent, lobes 5, triangular, glabrous. Corolla white, tube 1.1-1.5 cm. long, funnel shaped, ribbed, on the outside along the middle of the petals, and ribs hairy, glabrous at the base, hairy below the middle, and then papillate upwards within, distinctly veined; lobes 5, *c.* 0.3 x 0.2 cm. Stamens 5, inserted on the corolla tube above the base; anthers oblong, glabrous, basifixed, introrse, and longitudinally dehiscent. Disc epigynous, glandular, of 2 large lobes. Ovary 2-loculed, ovules many on basal ascending placenta; style filiform, glabrous; stigma 2-lobed with linear-lanceolate lobes. Capsules 0.4-0.5 x 0.7-0.8 cm, obovoid, compressed, pilose, girt by calyx limb. Seeds minute, angled, reticulate.

Flowering and Fruiting: Throughout the year.

Habitat: Evergreen forest.

Etymology: The specific epithet *shendurunii* is after the renowned Wildlife Sanctuary Shenduruni, the type locality of the taxon.

ACKNOWLEDGEMENTS

We are thankful to Dr Dianae M. Bridson, Kew for her critical comments on the taxon and Prof. N. Ravi, Emeritus scientist, TBGRI for going through the manuscript. Our gratitude to Dr. V.B. Hosagoudar, Scientist, TBGRI for the Latin diagnosis.

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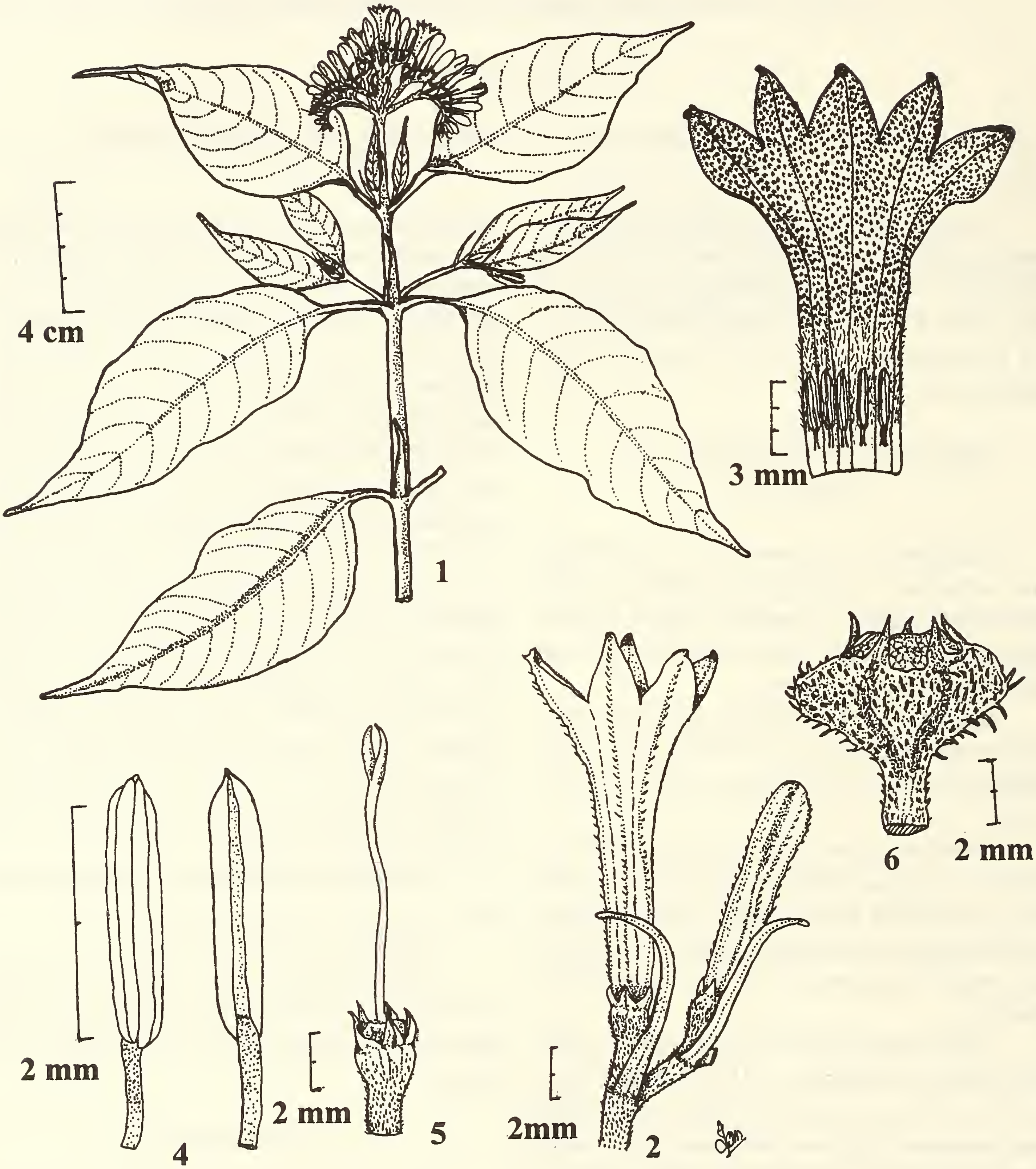
4 cm
1
3 mm
6
2 mm
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2 mm
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2mm
2

Fig. 1-6. *Ophiorrhiza shendurunii* sp. nov.
1. Habit; 2. A flower and flower bud; 3. Corolla exposed; 4. Stamens; 5. Gynaecium;
6. Capsule.

A NEW SPECIES OF *CALANTHE* R.BR (ORCHIDACEAE) FROM SIKKIM HIMALAYA[1]

S.Z. Lucksom[2]

(*With eight text-figures*)

While carrying out floristic survey of West Sikkim during May 1996, the author came across one interesting plant belonging to family Orchidaceae. On critical study, this was found to be a new species of *Calanthe* R.Br which is being described here with an illustration.

Calanthe yuksomnensis S.Z. Lucksom sp. nov.

Calanthe herbacea Lindl affinis sed differt Folia 3, 50-60 cm longa, petiolata; lamina 20-30 x 6-12.10 cm, elliptico-lanceolata, acuta; petiolus 20-30 cm longus, canaliculatus. Inflorescentia 20-30 cm longa, teres, puberula; Pedunculus 15-26 cm longus, erectus, teres, cum bractea una, lanceolata 1 cm longa; Racemus 5-7 cm longus, teres, puberulus cum 2-10 floribus pedicellatis. Flores 3.3-4.2 cm diametro, albido-brunnei, parum fragrantes. Sepala sub-equalia, patentia, extus puberula, 5-nervia, brunneo-purpurea, apices basique viridia; Sepalum dorsale 1.85-1.95 x 0.76-0.82 cm, ellipticum, acutum; Sepala lateralia 2-2.1 x 0.58-0.61 cm, Oblonga Vel parum falcata, acuta, 5-7 nervia. Petala 1.7-1.75 x 0.4-0.5 cm, rhomboidea, parum acuminata, 3-nervia, utrinque glabra, ejusdem coloris quam sepala, sed pallidiores. Labium 2.35-2.40 x 1.8-1.9 cm, cremeus; lobus lateralis oblongo-ovatus, parallelus lobum apicalem, lobus apicalis sub-reniformis, ad picem cum lobulis duobus, sub-obovatis, obtusis, parum fimbriatis, parum divergentibusque, separatis a sino triangulari, discus inter lobus laterales cum callis tribus vadosis elongatisque, crescentibuse basi et convergentibus versus sinum apicalem.

DESCRIPTION

Pseudobulb 2-3 x 1.5-2 cm, ovoid, with 2 to 3 annular rings, new pseudobulb develops from the side of the old one carrying new leaves and an inflorescence enclosed in 3, tubular sheathing bracts 3.8-8 cm long. Leaves 3, 50-60 cm long, petiolate; lamina 20-30 x 6-12.1 cm, elliptic-lanceolate, acute; petiole 20-30 cm long channelled.

Inflorescence 20-30 cm long, tere, puberulous; peduncle 15-26 cm long, erect, terete with one 1 cm long lanceolate bract; Raceme 5-7 cm long, terete, puberulous, with 2-10 pedicellate flowers. Flowers 3.3-4.2 cm across, whitish-brown, with mild fragrance; sepals sub-equal, spreading, puberulous outside, 5-nerved, brownish-purple with green tips and base; dorsal sepal 1.85-1.95 x 0.76-0.82 cm elliptic, acute, 5-7 nerved. Petals 1.7-1.75 x 0.4-0.5 cm, rhomboid, slightly acuminate, 3-nerved, both side glabrous, colour shade same as sepals but lighter in shade, spreading lip 2.35-2.40 x 1.8-1.9 cm, oblong in general, creamish white, its lower *ca* 7.5 mm part adnate to the column throughout; lateral lobes oblong-ovate, obtuse, it inner line parallel to apical lobe; apical lobe sub-reniform, its apex with two sub-obovate, blunt, slightly fringed, slightly diverging lobules separated by a triangular sinus; the disc with three shallow elongated calli starting from base and converging towards apical sinus. Spur *ca*

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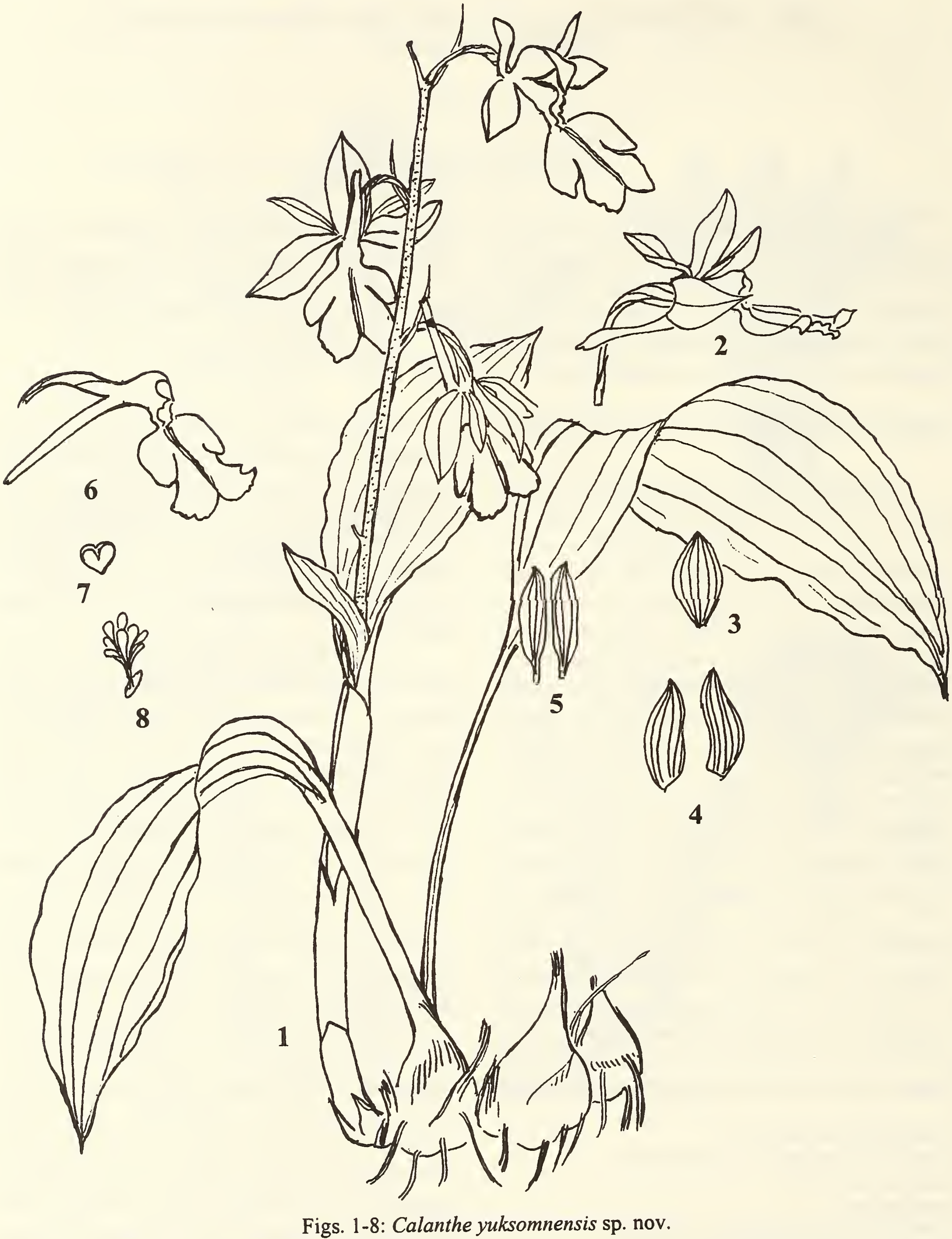

Figs. 1-8: *Calanthe yuksomnensis* sp. nov.
1. Whole plant; 2. A single flower; 3. Dorsal sepal; 4. Lateral sepal; 5. Petals; 6. Flowering parts showing pedicellate ovary, spur, column and lip; 7. Anther; 8. Pollinia.

TABLE 1

COMPARISON BETWEEN CALANTHE YUKSOMNENSIS AND CALANTHE HERBACEA

		Calanthe yuksomnensis sp.nov.	*Calanthe herbacea* Lindl.
1.	Leaves:	2, lamina 20-30 x 6-12.1 cm elliptic-lanceolate, acute, petiole 20-30 cm long, channelled.	5-7, lamina 14.5-30 x 5-9.7 cm, elliptic, caudate-acuminate; petiole 9-24 cm long.
2.	Inflorescence:	20-30 cm tall, puberulous; Raceme 5-7 cm long, with 2-10 flowers.	60-94 cm, smooth; Raceme 15-27 cm long, with many flowers.
3.	Flowers:	3.3-4.2 cm across.	2-2.7 cm across.
4.	Sepals:	brownish-purple with green tips and bases; dorsal sepals 1.85-1.95 x 0.76-0.82 cm; Lateral sepals 2-2.1 x 0.58-0.61 cm.	pale-green; dorsal sepal 1.3-1.7 x 0.5-0.7 cm, lateral sepals 0.8-1.0 x 0.5 - 0.69 cm
5.	Petals:	1.7-1.75 x 0.4-0.5 cm, rhomboid.	1.3-1.6 x 0.3-0.5 cm, sub-spathulate.
6.	Lip:	2.35-2.40 x 1.8-1.9 cm, creamish-white; disc with 3 shallow longitudinal calli running from base to apex; lateral lobes not diverging but lie side by side (parallel) to apical lobe; apical lobe broad with shallow bilobulate tips, bilobulate tips slightly diverging with obscurely fimbriate margin.	2.5-2.8 cm long, pure white, yellowing on maturity, with a warty triangular yellow callus at its base; lateral lobes diverging; apical lobe considerably bilobulate, narrower; diverging; with smooth margin.

2.3 cm long, straight, cylindric, with slight cleft at basal end. Column *ca* 7.5 mm long. Anther ovate. Pollinia 8, *ca* 3-3.2 mm long, obovate or clavate, sub-equal, yellow; disc *ca* 9.5 mm long, oblong-ovate, translucent white.

Typus: INDIA: Sikkim, Yuksom; 20.v.1996, Coll. Lucksom 311a (Holotypus CA CAL)

Isotypus: b,c,d Gangtok, Forest Department, Herb.

Flowers: May and June.

Grows on forest floor at 1400-1800 m.

The fresh flowering plants collected during the survey were examined and found to be entirely different from other *Calanthe* species.

Terrestrial, pseudobulbous plants, with large plicate leaves. Inflorescence a tall spike arising from leafy axis; lip adnate to the short column throughout its whole length, and 8 pollinia, are some of the characteristic features which justify the placement of this taxon under the genus *Calanthe* of subtribe *Blentinae*.

The new taxon is closely allied to *Calanthe herbacea* Lindl from Sikkim Himalaya, but differs in some characters (Table 1).

Etymology: The new species is named after the place from where it was collected.

ACKNOWLEDGEMENTS

I am grateful to PCCF-cum-Secretary, Forest Department, Government of Sikkim for permission to carry out a survey of orchids. I thank Mrs Kalyani Thapa, Curator, Forest Department, for preparation of herbarium sheets and Dr N.C. Majumdar, Scientist, SE, (Rtd.) Botanical Survey of India for rendering the Latin translation.

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A NEW SPECIES OF *SIDA* FROM AGRA, INDIA[1]

S.C. PANDEYA[2]

(*With six text-figures*)

Sida hemitropousa from Agra, India, has been described as a new species.

Examination of plant collection made at Agra, India, from 1992 to 1995 revealed the existence of a new species of *Sida*, which is confused with *S. acuta* Burm.f. The holotype is in the Kew Herbarium (vide ours 1508), identified by them as *S. acuta* (December 3, 1993).

Genus *Sida* Linn. Sp. Pl. 2:683, 1753; Gen. Pl. ed. 5, 306, 1754

Sida hemitropousa Pandeya sp. nov.

Perennial erect shrub upto 1.5 m; *leaves* simple, lanceolate, 2-4.5 x 1-1.3 cm, margins serrate, apex acute; *stem* brown, both stem and leaves minutely hairy; *lamina* bluish green; *petiole* 2-4.5 mm long; *stipules* linear, hairy, 0.8-1.2 cm; flowers 2-4 in axil of leaves; *pedicel* 2-4 mm, reddish brown; *bracteole* 0; *sepals* 5, valvate, lower half connate, lobes 5, central vein purple, deltoid, caudate-acuminate, ciliate; *petals* 5, 5-8 mm across, 2-lobed, free above and connate below, adnate to the tube of stamens pale yellow; *staminal tube* divided at the summit into 20-32 anthers bearing filaments; *carpels* 5, *styles* 5, connate at lower half, *stigma* 5, longer than anther tube, capitate, 4 carpels abortive, only one develops one pendulous seed; *seed* dark brown, smooth; carpels with 2 small awns; anthers do not dehisce in many cases; after 4-5 hours (around 1300 hrs) petals curl in to close the flower.

Fruit: hemitropous, roundish; 50% flowers abortive.

Flowering: September to April (Fig. 1). Local name not known.

Habitat: roadside and edges of gardens.

MAIN DIFFERENCES BETWEEN *SIDA ACUTA* AND *S. HEMITROPOUSA*

Characters	*Sida acuta*	*S. hemitropousa*
Habit	Spreading undershrub, 1m	Erect undershrub, 1.5 m
Stem	Glabrous, olive green	Reddish brown, stellately hairy
Leaves	Elliptic-lanceolate, base obtuse, olive green, glabrous 2-6 x 2-4 cm	Lanceolate, dark green (bluish), minutely hairy, 2-4.5 x 1-1.3 cm
Petiole	3 - 6 mm	2 - 4.5 mm
Stipule	7 - 8 mm	8 - 12 mm
Flowers	Calyx 6-7 mm, petals 8-10 mm across; carpels 6, rugose, two aristate, 2 mm	Calyx 2-4 mm, lower half connate, petals 5-8 mm, carpels 5, 4 carpels abortive, carpels shortly (1 mm) 2-awned
Fruit	Schizocarp with awns pointing upwards in line with pedicels, 6 seeded, one in each mericarp	Hemitropous with small awns situated at right angles to pedicel, single seed only in upper carpel

Distribution: Agra and its environs. Characters which make it different from the allied species, viz., *Sida acuta*:

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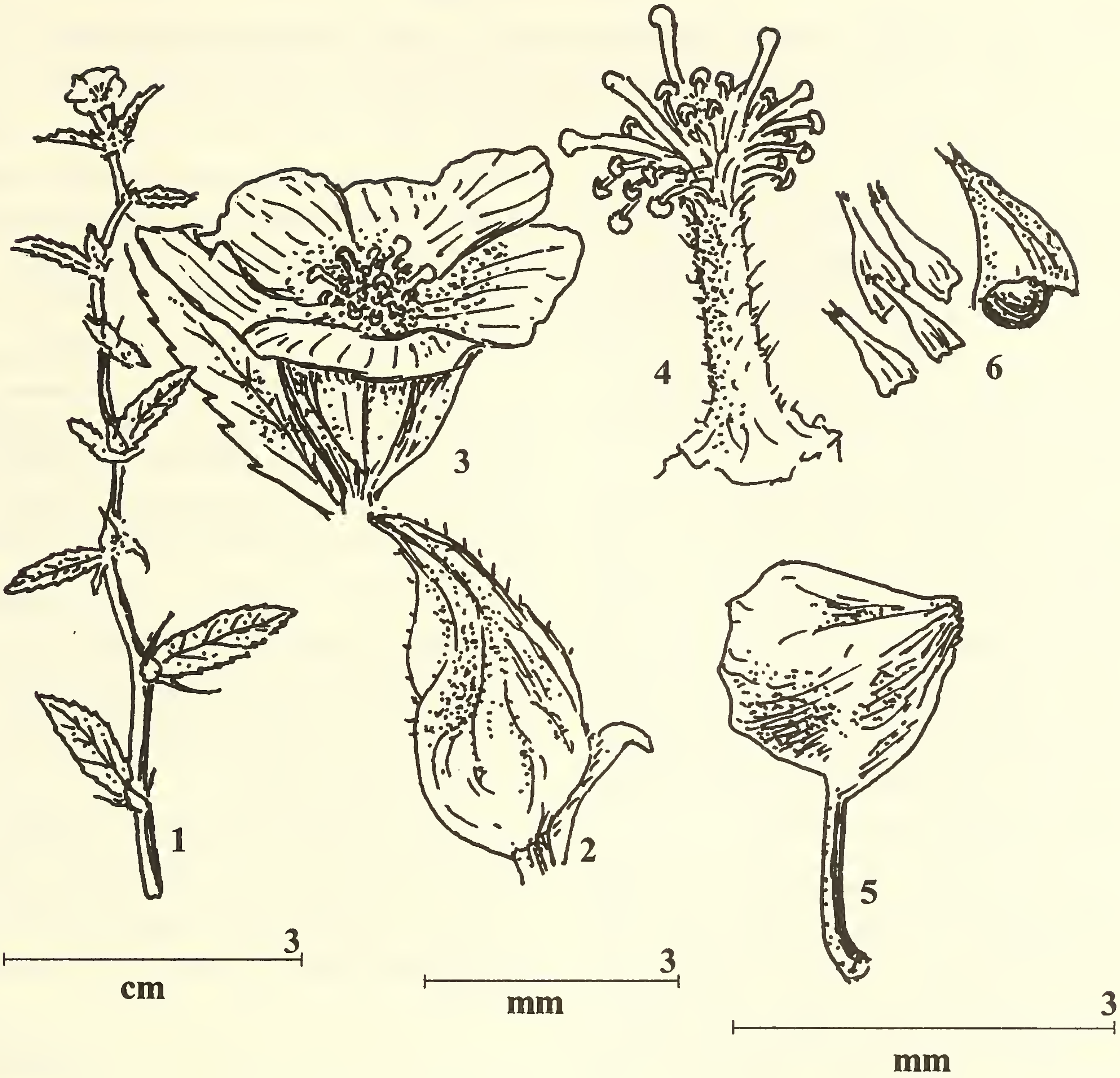

Figs. 1-6. *Sida hemitropousa*: 1. A flowering shoot, 2. Flower bud, 3. Open flower in axil of leaf (2 and 3 of same magnification), 4. Styles longer than filaments, hence stigma protruding out of bunch of anthers, 5. Fruit hemitropous, roundish, 6. Carpels 5, (4, 5 and 6 of same magnification)

Sida hemitropousa Pandeya sp. nov. affinis *S. acuta* Burm. f. Frutex caulibus 1.5 m alta; Cortice basi arbor; folia lanceolatus, serrato-pubescentibus, floris petala flavi-pubescentibus; stamina 20-32; Stigma 5, longa, stigma quam stamina longier; Ovule 5, 4 abortive; fructo hemitropous, uno seminibus; 50% floris abortive; Floris September - April.

Etymology: The species has been named after hemitropous shape of the fruit.

REVIEWS

1. ADVANCES IN FISH AND WILDLIFE ECOLOGY AND BIOLOGY Vol. 1 Bsansi Lal Kaul, Daya Publishing House, Delhi, 1996. pp i-xiii+332 (24.5 x 16 cm) ISBN 81 - 7035-156-1 Price Rs. 700/-

The book deals with the areas of Limnology, Fish and Wildlife ecology, as well as Biology. It marks the beginning of a series of such volumes that shall attempt to reflect the latest as well as original research work related to environmental issues which are gaining a lot of importance because of increased pressure on water and land resources due to proliferation of human population.

As an inaugural volume, the book has been dedicated to Prof. Y.R. Malhotra on his completion of 40 yrs. of teaching and research. This book includes articles from experts in different fields, many of whom have been students of Prof. Malhotra. The present volume, which is edited by Prof. Bansi Lal Kaul, contains an appreciation of Prof. Malhotra from Prof. P.L. Dua and is a compendium of original research articles contributed by 20 authors.

The book has two sections: Section I contains 21 articles under the heading "Fish and Limnology" and pertains to various topics like fish structure, fish food organisms, aquatic insects, feeding habits, reproduction, development and many other related topics on fish ecology and biology. Section II contains 8 contributions under the heading Wildlife. This section includes chapters on habitat studies, behaviour, management of wildlife, threat to wildlife and shrinking wetlands. Finally there is an Index of six pages.

The volume is an exhaustive collection of information in the fields specified. However, it is oriented towards specialised research findings and is more useful to researchers in pursuit of excellence. Most of the chapters, deal with specific observations in the Jammu and Kashmir area.

With the recent advances in printing technology, coloured photos and sketches could have been included in a few selected chapters, and such plates would have made the book more interesting and attractive visually, and useful even for general readers.

This is a sincere attempt to compile the recent knowledge in emerging fields which assume more importance because the very survival of mankind will be threatened if there is an indiscriminate pressure upon water and land resources.

V.V. SINGH

2. VERMICOLOGY - The Biology of Earthworms by Sultana A Ismail. 92 pp (21.5 x 13.7 cm) with 12 colour photos and many illustrations, Orient Longman Ltd. Hyderabad, 1997. Price: Rs. 75/-

With vermiculture being popular everywhere several books have come out in the market on this subject. VERMICOLOGY - THE BIOLOGY OF EARTHWORMS is one of them.

Out of 92 pages, 17 pages are devoted to the bibliography and 2 pages to a glossary. The book has nine chapters dealing with Ecological types of earthworms, their structure and life cycles. The chapter "earthworm for culture" provides information on species used for vermiculture, their breeding and vermicompost.

The chapter "vermiculture and vermitech" will be of interest to the beginner, as it provides information on how to start vermiculture, preparation of vermibeds and effective time table for proper harvesting of vermicompost through the twin unit system of vermitech.

Subjects like the effect of earthworms on plant growth, their use in vegetable growing and impact of chemicals on earthworms are dealt with in the chapter "Experiments from the field". The role of earthworms in agriculture is evident by some experiments mentioned in the chapter "Earthworms: Their application in organic Agriculture." The book will be useful to all those who are interested in vermiculture.

NARESH CHATURVEDI

3. IMPACT OF DISEASES AND INSECT PESTS IN TROPICAL FORESTS

Edited by K.S.S. Nair, J.K. Sharma and R.V. Varma 1996. Kerala Forest Research Institute (KFRI) and Forestry Research Support Programme for Asia and the Pacific, pp 521 (24 x 17 cm). Price not stated.

The book is a compendium of papers presented at the symposium *Impact of Diseases and Insect Pests in Tropical Forests* organised by KFRI jointly with (IUFRO) International Union of Forestry Research Organisations and Forestry Research Support Programme for Asia and the Pacific.

The book is divided into two parts, each having 4 sections. Section I of the first part of the book deals with Impact of Diseases & Parasites on Productivity of Forest Trees and Bamboo Stands. A chapter provides information on impact of seed microflora on seed germination and seedling vigour of some important indigenous tree species of Kerala.

The management of disease is dealt under Section II. Information on Disease Epidemiology is given under Section III and Section IV is entitled Symbiotic Microbes in Relation to Disease.

Section I under Part 2 highlights the impact of Insect Pests on forest trees like teak, mahogany and *Ailanthus.* A chapter each deals with Borer pests, the threat to coastal forests of Bangladesh and Threat to Mangrove Vegetation from Marine Wood boring and Fouling Organisms along the Indian Coast. In all there are 13 chapters in this Section. Information on Pest Management is given in Section II. The Biology, Ecology & Control of Insect Pests are given under Section III, having 14 chapters. Section IV on Problem Statements has nine chapters followed by Recommendations of the Symposium.

The papers published in this compendium include contributions from various countries i.e. Australia, Bangladesh, Canada, Cameroon, Fiji, Indonesia, Italy, Malaysia, Nepal, Norway, Pakistan, South Africa, Sri Lanka, United Kingdom, Vietnam and India. The book does not have an index which is a major shortcoming.

The book provides information not only on disease and insect pests of forestry but also their impact on productivity of the trees.

A valuable publication for all researchers associated with forest management.

NARESH CHATURVEDI

4. FLORA OF MAHARASHTRA Vol. I, M.R. Almeida. St. Xavier's College, Bombay-400 001. 1996. pp. i-lxxix, 1-294, i-xciv: (22 x 29 cm). Hard back Rs. 1000.00

The state of Maharashtra comprises a large part of the earlier Bombay state. This region is fortunate is having a variety of vegetation types, and consequently very rich flora. Some spots in the Western Ghats are centres of speciation, and many new taxa have been discovered from the region of Mahabaleshwar, Khandala and other areas. The region also attracted good field botanists and taxonomists right from the nineteenth century. Among the main workers of this century at the Blatter Herbarium, the names of Fr. E. Blatter, Fr. H. Santapau, Prof. P.V. Bole and more recently, Dr. S.M. Almeida are the foremost. These persons made a tradition of training dozens of men and women in painstaking field work and critical taxonomic studies. This training resulted also in building up of an excellent herbarium now called Blatter Herbarium in St. Xavier's College.

The present flora of Maharashtra and its author are both products of this institution and its tradition. Vol. I of Flora of Maharashtra deals with families Ranunculaceae to (actually) Staphyleaceae. Somehow on the cover page it reads Ranunculaceae to Connaraceae. Though the book can, in one sense, be said to be a revision of Cooke's FLORA OF BOMBAY PRESIDENCY, in reality it is much more. Many additional plants, localities, and other updated information make it a new work altogether.

The initial 80 pages deal with the area, its physiography, drainage, rainfall, climate, soil, vegetation, detailed history of botanising, floristics and methodology.

A critical analysis is given of genera not included in Cooke's Flora, nor in Santapau and Henry's DICTIONARY OF PLANT GENERA IN INDIA.

Many new taxa found by the author and his well known taxonomist wife Dr. S.M. Almeida are listed.

In the main text, the family accounts have indented keys to genera, and species, citations, synonymy, occasionally local names, brief description, flowering time and distribution. Nomenclature is good.

The descriptions are quite precise. The distribution has several new localities not recorded in Cooke's Flora or later works on district floras.

There are many line drawings or photographs to illustrate species and vegetation types. There is, however, inconsistency in providing scales to figures. Some have scale marking (plate 19, p. 2), many do not (foll. p. 4). Numbers on a few plates seem to have been added inadvertantly, as most other plates have no numbers.

There is considerable anomaly in numbers of plates and photos, e.g. towards end of the book. Nos. 88-89 after p. 293 appear after 94-96 (p. 270). Some colour plates have no numbers (*Cissus, Eriolaena*). Others have a curious no. TP. (*Salacia, Sapindus,* etc.).

The quality of line drawings is good, but colour pictures vary from very good (No. 26,32-35) to ordinary (*Cissus,* No. 17).

The book ends with a bibliography, and indices to scientific and local names and a one page Errata.

The use of Roman numbers for 79 pp. (i-lxxix) in the beginning and again 94 pp. (i-xciv) at the end is a little confusing.

The size of the book is rather large for frequent handling by students, but this will be compensated by a lesser total number of volumes.

The author and his wife deserve congratulations for this long awaited Flora of a botanically important state of India.

S.K. JAIN

MISCELLANEOUS NOTES

1. WOLVES IN PANNA NATIONAL PARK

On a hot afternoon at the end of February 1996, while studying the ecology of sloth bears in Panna National Park, my supervisor Dr. A.J.T. Johnsingh saw two handsome wolves, at a place about two km from my camp at Talgaon village, close to the southern boundary of the Park. Unfortunately I was not with him. Since then, I had been longing to see a wolf in Panna, as I had never seen one before.

The next winter, during mid December 1996, I sighted a pack of four wolves about one km from my camp, about two o'clock in the afternoon closer to the southern boundary of Talgaon village crossing the road towards the village. They ran on seeing me. I followed them through the *Lantana* bushes for about 100 m till they disappeared. Two of them were slightly smaller than the other two, and their sex could not be identified. After looking out for them for a while, I returned to radio tracking sloth bears. That evening, when I returned to my camp I was told by a field assistant that the wolves had gone to the outskirts of the village and killed a cattle calf in broad daylight. The calf had been grazing in a fallow field along with several other calves.

During that winter, until mid February 1997, I continued to find evidence of the wolves' presence — tracks, scats — and once heard a howl. I came across 8 scats of wolves along roads and cattle trails. I conducted on the spot analyses to identify the major prey remains in the scats. I found thick locks of hair of black goats in 6 scats, and two possibly contained cattle hair. The scats were very similar to those of dholes, which were also found in Panna. However, the accompanying tracks (wolves have proportionately larger pads) helped in distinguishing them as wolf scats.

All the scats were collected within a radius of 4 km around Talgaon village. This area falls in my intensive study area, and sampling could have been disproportionate due to that. However, based on the sightings of others and my occasional visits to other areas of the Park, which have abundant potential prey, I formed the idea that they occur only along the periphery of the forests or occupy the areas around human settlements. Other places from where they have been reported are near the village of Jhalar, inside the park and Hinota, which is on the periphery. The villages inside Panna have a large population of livestock, as the villagers are traditionally dependent upon them for their livelihood. The landscape of Panna and the forests around it is basically a mosaic of forest, open scrub and villages.

Such a landscape must have provided adequate resources for long ranging species like the wolf to survive over the years. Jhala (1993) states that scrubland and grassland of the semi-arid parts of peninsular India are the preferred habitats of the Indian wolf. They do not occur in closed forests, but sometimes inhabit the periphery of such forests.

During the last year I was in Panna, I could find evidence of wolf only during the winter (post monsoon) season. An interesting event here is the presence of a large number of immigrant cattle inside the Park during the postmonsoon season, when forage is abundant. This seasonal movement of livestock might have been a traditional practice over several centuries, though recently this has been controlled to a great extent by the Park authorities. I interviewed the local cattle grazers and shepherds who said that the wolves were seen frequently only during the winter, mostly preying upon goats and cattle calves, and were a menace to their livestock. This supported my observation that these wolves used areas around Talgaon only seasonally.

The two sightings we have had were of a group of two and four. Local people also said that they had mostly seen them in groups of not more than four. Jhala (1993) observes that wolves that subsist on domestic livestock in other parts of India form smaller packs (1-4 invididuals) in contrast to the ones that subsist on wild prey (6-14 individuals). In Panna, interestingly, the wolves occur along with dhole in the same area. However, I sighted dholes only infrequently and only in less disturbed, denser parts of Panna. Thus, the preferred habitats of these two species seem to vary. Generally, it is believed that these large, similar sized canids segregate their habitats due to interspecific competition. But in places like Panna, where the landscape is a mosaic of habitats providing niches for both the species, they are found to occur together.

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2. OCCURRENCE OF THE WOLF *CANIS LUPUS PALLIPES* LINN. IN SIDHI DISTRICT, MADHYA PRADESH

In *JBNHS* 93 (1): 81, I read an article by Shri A.M.K. Bharos mentioning the sighting of a solitary wolf in March, 1993 while travelling in Chhuhiyaghat on the border of Rewa and Sidhi districts.

I have also sighted a solitary wolf, which in all probability was a large male, on the outskirts of the Dhubri Sanctuary situated in the western part of Sidhi district in Madhya Pradesh, in February, 1981.

I have also seen a female wolf, in rather poor condition, on the road to Chiklod in Raisen district of Madhya Pradesh, in the monsoon of 1982.

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3. THE ROLE OF ADMINISTRATION IN EXTERMINATION: FRESH EVIDENCE ON THE CHEETAH (*ACINONYX JUBATUS*) IN INDIA

The chronology and sequence of the extermination of the Asiatic cheetah provided in the only full length work on the subject relies on books and journal records. However, as the author admits it is often not possible 'to ascribe a definite date' as these are not given in the texts. Secondly, the giving out of rewards for killing adult cheetahs and cubs was widely practised from at least 1871 onwards, but this information is mainly in the archival records. By consulting such records, it is possible to fill gaps in the chronology of extinction. The fact that government money was given out meant that skins had to be shown as proof. Unfortunately, 'leopards and cheetahs' are often listed together. But by eliminating all such instances and selecting only figures from files where 'cheetahs' and 'leopards' are listed separately, it is possible to revise the estimated number of cheetahs killed in India. Divyabhanusinh (1995: 197-205) gives us a total of 127 cheetahs that were captured, killed, painted or photographed between 1800-1950. This thoroughly researched list does not include those killed for rewards. The total as shown in Tables 1 and 2 comes to not less than 70 cheetahs in addition to his figure. It is possible

TABLE 1
ARCHIVAL RECORDS OF KILLING OF CHEETAH FOR REWARDS

Date	Location	Remarks	Source
Oct. 1872 to Sept. 1873	North West Provinces; Mirzapur district only	8 `Chitas; killed for reward Rs. 37-8 annas 4 `tendua' (leopad) also listed separately	NAI, H (P) Jan. 1875, A, 286-311, No. 296: HJA Sparks, Offg. Under Secy., Oudh, 20 Dec. 1873.
1874	Tirunelveli Dist., Madras Presidency	16 cheetahs killed for rewards of Rs. 287, rate of Rs. 18 each, thrice the NWPs rate. Leopard and cheetah are listed separately.	H (P), May 1877, A, 60-85, No. 60, CA Galton, Secy. No. 20 Dec. 1876
1875	Bellary District	5 cheetah for Rs. 61; rate Rs. 12 each; 17 leopards too.	H (P), Dec. 1877 A, 269-92, No. 269, CG Master 21 Sep. 1877.
1875	Tirunelveli	16 cheetahs killed; leopards are listed separately.	As above
1876	Madras Presidency	135 cheetah and 507 leopards killed. The former figure is suspect except for 8 in Bellary where leopards given separately. Tirunelveli (11). North Arcot (40) - but leopards are not listed separately. The former figure is close to the 1876 one. The total may be taken as 19; Coimbatore (21) but has no listing of leopards at all.	H (P), Dec. 1878, A, Nos. 249-80, No. 286: Board of Revenue Proceedings, 2 Aug. 1878.
1901	Madura, South Canara	1 killed for reward; 3 more for Rs. 50 reward.	H (P) Sep. 1902, A, No. 281-99, No. 281, pp. 6-7 L. Davidson, Secy., Board of Revenue, 13 March 1902.
1889	North Arcot	2 cheetah cubs for a ttoal Rs. 25 bounty.	H (P) Dec. 1890, A, Nos. 360-407, no. 363, p. 32: H L. Davidson, Collector North Arcot to Secy Board, May 1890.
1903	Madura Tirunelveli	3 cheetah, no reward paid: 1 killed, skin taken as trophy.	H (P) Oct. 1903 A Nos. 237-55 no. 237, p.: Resn., Rev. Dept., 10 Mar. 1903.
1901	S. Canara	3 killed, listed in 1903 file.	As Above, p. 10.
1903	S. Canara	3 cheetah, no reward paid.	H (P) Dec. 1904, A 50-66 No. 50, Rev. Dept Madras, Procs.: 25 Mar. 1904.

TABLE 2
FURTHER RECORDS OF CHEETAH

Date	Place/Location	Remarks	Source
1892	Akoka district, Berar, near Ajanta Ghats.	Lived, bred, preyed on antelope and gazelle, trapped by villagers and up-country rajas.	King Martin, 1935: 83-84.
Early 20th century	Nandikottur, Kurnool District.	Cubs captured; Pair of adults known to Chita Pardhis, a tribe of specialist hunters.	Mankadan (1988: 18-20).
1898	Moyar-Bhavani rivers junction, west of Satyamangalam, Coimbatore district. Bhavani taluqa cheetah and tiger reported.	1 cheetah shot, 5 killed for rewards. Then the area had wolf, nilgai, bustard, florican, black buck antelope.	Nicholson, 1887: Vol II, p. 12.
1916	Nagpur, Yeotmal Districts, CPs & Berar.	Permission to trap cheetah for Nizam, Hyderabad. the file is missing in the National Archives of India.	India Office Agri. Library and Records,: Forests, P/9912, June 1916, B, 12.
1920s	Central Provinces.	Princes try trapping but fail.	JP Hewitt, 1938: 9.
1927	Kopbal, Hyderabad.	Trappers sent by Raja of Kolhapur.	HY Ghorpade 1952: 103-9.
1904	Sihawa, Raipur Dist. CPs.	2 cheetahs shot.	AG Nelson, 1909: 25
1910	Ghatbori and Hiwarched forests dist. Berar.	Recorded as present, none killed; `only a few' in Ajanta hills.	AG Nelson, 1910: 16-17.
1910	Drug Dist, CPs.	Uncommon.	AD Lowrie, 1910: 24-28.
1914	Ranipur, Betul, CPs.	Heard of at camp, not seen.	King Martin, 1935: 194.

the actual figure was higher.

It is not easy to estimate how killing for rewards might have affected the wild population. Unlike in case of mature animals captured for coursing, the specimens killed for rewards included cheetah cubs. For instance, in Sindh, Rs. 6 were given for a cub as against Rs. 12 for an adult (National Archives of India, Home

(Public), September, 1871, A, 43-72, pp. 6,9: Circular to local govt., 29 January 1870). Secondly, the substantial rewards may have induced tribals or caste Hindu peasants with knowledge of the habits and the habitat of the cheetah to exert fresh pressures on it. Third, the rewards almost all refer to British India. There were exceptions, with bounties being given in 1842 for both cheetahs and leopards in parts of Kathiawar. (Le Grand Jacob, 1843: 57, 37-38). This may, in general, explain why the species survived longer in some princely states in central India and the Deccan than in most of British India. Fourth, given the increasing rarity of the cheetah in India by 1900, it is possible that bounty-hunting added to other pressures such as the decline of the prey base, conversion of open scrub or grassland to permanent cultivation or shooting. The extent of killing for rewards was obviously high. Fresh work is required to ascertain how far it hastened the extinction of the cheetah in India. The average number killed for rewards in the period 1870-1925 is more than 1.2 per year. By contrast, in the entire period 1800-1950, a total of 127 (a statistical average of less than one a year) were shot, speared or trapped. This might suggest that bounty-hunting led to a higher rate of killing of cheetah in the last quarter of the 19th century.

In Divyabhanusinh's chart, as many as 62 were shot or captured in the same period: about half in the entire 150 year period. If the numbers shot or caught for sport and those eliminated for reward are totalled, (75+62=137), the average comes to over 2.49 animals a year in 1870-1925. This complements the view that this period saw a sharp decline in numbers, but it adds a new qualitative factor that may have exerted even more of an adverse impact than sport-hunting.

The mere killing of adult or juvenile animals or even of cubs is in itself no indicator of the human impact on predator populations. Given an adequate prey base and sufficient living space, there is no reason a carnivore should vanish or even decline due to trapping, either live or dead, or because of sport-hunting. But there is little doubt, if the recorded number of sightings of cheetahs in the wild is any indicator, that it was never an abundant species in India, or at least, this was not the case by the late nineteenth century. Bounty-hunting, therefore, may have hastened, if not caused, its decline in many localities where it still survived. given the relatively low density at which it existed, even the removal of a small number of animals could have had an adverse impact on the ability of wild populations to reproduce even at the minimal level essential for survival. In Mirzapur district in the North-West Provinces, eight cheetahs were killed by bounty-hunters for rewards in 1872-73 (NAI, H (P), Jan. 1875, A, nos. 286-296, no. 296, no pagination). Then, between 1894 and 1919, 5 were shot or killed (Allen, 1920:1041). Even this level of pressure helped exterminate the cheetah in the district. There are records of cheetah in Mirzapur after the mid-1920s. This one case illustrates how the process of extermination may have occurred at the local level.

But the habitat of the cheetah was not confined to the grass-covered plains of north India, the semi-arid tracts of Rajasthan and Gujarat or to the low, rocky outcrops of the central Indian highlands. Archival evidence and hunting records both point to its range having been much further south. The District Manual of Coimbatore district in Madras Presidency is especially valuable. It records how five cheetah skins, as distinct from panther skins, were stored in the government office. The Manual also describes the forests of the Satyamangalam forest division and the Bhavani taluka. The vegetation of northern Coimbatore in 1887 was not unlike the thorn forests of the Deccan; it still had over 300 blackbuck, wolf, bustard, florican and even a few nilgai. The distribution of the cheetah on both sides of the river Bhavani was 'sparse' but there is no doubt that the species had been present in the recent past (Nicholson 1887, vol. II: 12).

The archival evidence on the killing of cheetah for bounties is backed by references in printed records such as district manuals, gazetteers and memoirs. But the former are far more detailed on the number of animals killed, the amount of rewards paid and the year in which bounties were given. What is crucial is that administrative policy played a major role in its extermination in British India. Much more work is required on the princely states to establish if this was, or was not, the case in these territories. But the level of the 'drain' on wild cheetah populations was substantially higher than has been supposed. Further, the species often disappeared before its prey base declined or its habitat was taken over for cultivation. It is, of course, possible, that bounty-killing exacted a heavier toll because of a relative decline, if not extinction, of wild prey species like the blackbuck. But the tracks on the trail do point to a larger role for direct extermination as opposed to indirect causes for the decline and eventual extinction of the cheetah in India.

In all there are 9 more instances of cheetahs seen or shot.

January 12, 1998 MAHESH RANGARAJAN
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4. ANTI-PREDATORY RESPONSE OF THE INDIAN GIANT SQUIRREL *RATUFA INDICA* TO PREDATION ATTEMPTS BY THE CRESTED HAWK EAGLE *SPIZAETUS CIRRHATUS LIMNAETUS*

Since most mammalian carnivores are nocturnal, birds of prey are likely to be the most important predators of diurnally active squirrels (Emmons 1980, Hall 1981). Most studies on temperate and tropical squirrel species have documented the importance of diurnally active raptors as predators over mammalian ones (Emmons 1980, Hall 1981, Borges 1993, Joshua 1992).

Ramachandran (1991), Joshua (1992),

Joshua and Johnsingh (1994) and Borges (1993) observed predation attempts by the black eagle (*Ictinaetus malayensis perniger*) and crested serpent eagle (*Spilornis cheela*) on the Indian giant squirrel and grizzled giant squirrel (*Ratufa macroura*).

I observed three unsuccessful predation attempts by the crested hawk-eagle (or changeable hawk-eagle) (*Spizaetus cirrhatus limnaetus*) on the Indian giant squirrel (*Ratufa indica*) during field work for a study on the Indian giant squirrel in Bori Wildlife Sanctuary (WLS), area (486 km^2) which lies in the Satpura hill ranges, (22° 19' to 22°30' N and 77° 56' to 78° 20' E), Madhya Pradesh. Though the crested serpent eagle was also seen frequently in the study area and elicited alarm calls from squirrels, I did not see any predation attempts by this species. Both the raptor species were usually sighted in the riparian area at mid-morning and frequently in the afternoons.

The major forest types in Bori WLS are dry to moist teak (*Tectona grandis*) forests and mixed forests (Champion and Seth 1968).

The study was conducted in two riverine patches surrounded by deciduous forests. One of these, along Bhainsa nala, suffered disturbance due to the presence of two villages, cattle grazing, a teak nursery and buildings of the Forest Corporation set up in 1975. Gaps exist in the forest canopy due to the felling of trees in the past. The other study site was a relatively undisturbed riparian habitat along Churnagundi nala, which flows into Bhainsa nala. Though cattle were seen here, the study area was largely free from human disturbance.

Five individually identified squirrels were observed from dawn to dusk using focal animal sampling (Altmann 1974). Focal animals were followed twice a month during the study period from December 1992 to April 1993. Two other individuals were also observed for 2 days each in December.

All predation attempts were observed in Bhainsa nala. In March, out of 6 observation days, raptors were sighted on 4 days. Two predation attempts were recorded at mid-morning, while one was observed in the afternoon.

One of the attempts occurred around 1000 hrs while observing a squirrel feeding on *Terminalia arjuna* fruits. Two other squirrels were feeding on the same tree. On a nearby *Bombax ceiba,* two more individuals were feeding on the red flowers. A crested hawk-eagle *Spizaetus cirrhatus limnaetus* flew in and perched on the tree. It did not seem to be hunting actively. Two squirrels immediately mobbed it, approaching close and giving loud alarm calls repeatedly. The hawk-eagle responded with wings outstretched, but seemed unperturbedand did not attempt to catch them. After a while, one of the squirrels left the *B. ceiba* tree and was moving along the branches of a *Terminalia tomentosa* tree when the eagle swooped down in an attempt to catch it. The squirrels, instead of fleeing, immediately turned and faced the predator with alarm calls. In the meantime, the other squirrel on the *Bombax ceiba* tree had also moved onto this tree and mobbed the predator. The three other squirrels on the adjacent *T. arjuna* tree also started calling in alarm. The hawk-eagle made a half-hearted attempt to catch one of the squirrels and then flew away through the canopy.

The second predation attempt was observed one afternoon in March while following a focal animal, which was resting inside its nest. At 1411 hrs, I observed another focal squirrel (a sub-adult male) on a *T. arjuna* tree across the nala. It had come out of its nest and was resting on a broad shady branch. A crested hawk-eagle flew in and made an unsuccessful attempt to catch it. The squirrel reacted with loud repeated alarm calls and 'mobbing' the hawk-eagle, approaching as close as 1-2 m. The crested hawk-eagle spread its wings six times in response to the mobbing and made another attempt to catch it with wings outspread. The squirrel called, moved down 3 m, but again approached the hawk-eagle. The crested hawk-eagle watched the squirrel, but appeared disinterested and even started preening its wing feathers. The squirrel kept the predator in sight and then at 1426 hrs it retreated to a lower branch 6-7 m away, continually giving alarm calls. At around 1428 hrs the squirrel was not visible anymore, since it had moved behind the trunk of the *Terminalia arjuna* tree. The crested hawk-eagle was still perched on the tree. At around 1437 hrs, another squirrel was seen moving onto the tree, but it did not notice the predator till it was very close. The hawk-eagle spread its wings and flew away. This squirrel gave alarm calls and then rested on the same branch.

I observed a third predation attempt by an immature crested hawk-eagle on the sub-adult male squirrel in the morning. The squirrel immediately emitted loud alarm calls, faced the eagle and approached it close instead of trying to hide or escape. The hawk-eagle seemed to have given up. It perched on a *T. arjuna* branch and started preening its wing feathers (displacement behaviour?). when the squirrel approached too close, it responded with outstretched wings but did not attempt to catch it.

On all these occasions, a prolonged predator-prey interaction was observed — the squirrel which was attacked responded by 'mobbing' the predator. In a manner which seemed suicidal, they approached the predator close (within 1 m) and gave repeated loud staccato calls in full view of the predator. This behaviour was seen only when a predator made an attack, or when the squirrel was sure that the predator had seen it. But on occasions when raptors flew overhead, squirrels refrained from giving any alarm call and remained quiet, either becoming alert or flattening their bodies against a branch. Squirrels gave loud alarm calls mostly on occasions when the predator came very close. This behaviour seems to lend anecdotal evidence for Zahavi's hypothesis that the function of the alarm call is not to warn conspecifics, neighbours or kin, but as a signal to the predator that it had been noticed. This is supported by the fact that during the 3 different predation attempts observed, the raptor seemed to be startled by the prey's response and did not attempt to catch the prey after the repeated mobbing. In social animals, it is likely that the function of the alarm call is to warn conspecifics or kin, but in a solitary territorial species like the giant squirrel this may be unlikely.

It is also possible that the predator was an immature eagle, and therefore the squirrels approached close and 'mobbed' it, or that it was not hunting actively. Emmons (1980) reports that African squirrels mob inactive predators. She has defined "mobbing" as an event where one or more squirrels of the same or different species give alarm calls and display in the neighbourhood of predators. Hall (1981) also describes incidents of unsuccessful predation attempts by immature red-tailed hawks where the squirrels did not seem to be frightened, and gave repeated alarm calls even when the predator was perched just 3 m above them.

The crested hawk-eagle has not been reported earlier as a predator of giant squirrels. In addition, this is the first reported instance of 'mobbing' of a predator by giant squirrels.

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5. A RECORD NUMBER OF BLACKNECKED GREBE *PODICEPS NIGRICOLLIS* FROM GUJARAT

We visited Okha (22° 15' N, 69° 01' E) in Jamnagar dist., Gujarat on December 28, 1996. On getting information of blacknecked grebe *Podiceps nigricollis* at the nearby Charakla salt farm (40 km. east of Okha), we reached there at 1720 hrs. We observed two salt water ponds measuring 2 sq. km and about 2 m deep, where the grebes had concentrated. Two neighbouring ponds of similar dimensions did not have any grebe. Since the grebes dive frequently and come to the surface at a short distance, we found it a little difficult to make an accurate count. A total count of 201 blacknecked grebe is a minimum estimated number but we believe the actual number to be a little higher. The other birds worth noting in the same area are as follows:

Flamingo	*Phoenicopterus roseus*	494
Lesser Flamingo	*Phoeniconaias minor*	315
Slenderbilled Gull	*Larus geni*	129

We also recorded 9 blacknecked grebe in a bird sanctuary at Porbander (21° 37' N, 69° 49' E) on December 31, 1996. 3 grebes previously sighted at the same site on April 1, 1996 indicate that they might be regular visitors to the area.

One of us (BMP) has also recorded the species in central Gujarat — one bird at Nalsarovar, 25.i.1996; one bird on Vadadhla irrigation tank in Vadodara dist. 17.i.1993; and one bird on Kanewal reservoir, in Kheda dist., 12.i.1988.

Though the blacknecked grebe is recorded breeding in Baluchistan, it is an uncommon winter visitor to Nepal, Uttar Pradesh, Punjab, Gujarat and Maharashtra (Ali and Ripley 1983). In Gujarat, the species has been recorded from sewage canals in Bhavnagar (Dharmakumarsinhji 1952) and salt pans of Jamnagar dist. (Naik *et al.* 1991). Ali (1945, 1954) had not recorded this species during his survey of the birds of Kutch and Gujarat. However, since 1987, a few birds are being reported from Gujarat every year during the Midwinter Waterfowl Census. Our present record of its number and distribution supports Ali and Ripley's (1983) presumption that the species possibly occurs more generally in northern India than is believed. Occurrence of 201 grebes at Charakla salt pans is the largest number recorded from Indian territory.

We are obliged to Shri Fatehsingh Jasol, I.A.S., of Gujarat, for information regarding the presence of the grebes. We also thank the Indian Council of Agricultural Research, New Delhi, for financial support.

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6. ON THE OCCURRENCE OF THE LESSER FRIGATE BIRD (*FREGATA MINOR*) IN MUMBAI, INDIA

On the evening of 18th June 1996, a strong wind started blowing from the sea, stirring up high waves. The storm continued throughout the night, with the wind blowing upto 80 km per hr. In the night several big ships drifted towards the shore and were stranded. The storm skirted Mumbai and went on towards Gujarat. The next morning it was cloudy, with the wind still blowing, but not as strong as it had been in the night.

In the morning two frigate birds were noticed from the 13th floor of a building overlooking Mumbai harbour. The birds were flying around quite high, with considerable ease on long wings. They looked completely dark brown, with longish forked tail and pale brown band on the underwing. They were about the size of a kite but a lot slimmer. Thrice the birds came very close to the building and could be examined quite closely. They were identified as lesser frigate birds (*Fregata minor*). We looked out for white patches under the wing but there were none. Comparing a published description and the birds seen, we concluded that the birds appeared to be males.

The only Indian specimen of lesser frigate bird is that of a storm blown one found entangled in a fishing net near Quilon, Kerala. The last sight records from the west coast are from Mumbai 43 years ago (Taylor 1953). Two recent sight records are from the eastern coast, both storm blown birds. Balachandran *et al.* (1984) sighted a straggler at Point Calimere on 23rd Dec. 1983 and Rao and Mohapatra (1992) at Sriharikota on 29th July, 1991.

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7. CANNIBALISM IN WOOLLYNECKED STORK *CICONIA EPISCOPUS*

Cannibalism has been observed in the family Ciconiidae, but this behaviour has never been reported for the woollynecked stork *Ciconia episcopus*. I observed this strange behaviour while studying the breeding biology of the woollynecked stork in Keoladeo National Park, Bharatpur, India.

In India, the woollynecked stork starts breeding with the onset of monsoon. I observed breeding from 1994 to 1996, In 1996, the nest under observation was at a height of 3 m from the ground on a kadamb tree (*Mitragyna parvifolia*) and observations were taken from a hide 10 m away. I could identify the sexes by their behaviour and facial markings. The male had a dark face with dark black lines around the eyes, while the female was lighter in colour. Both parents shared incubation and collection of nesting material. On 1 August 1996, the eggs began to hatch after 30 days of incubation. There were three nestlings in the nest with three days interval from first to last hatching. The eldest nestling was dominant in picking up the food regurgitated by the adults on the nest floor. On 24 August 1996, the nest was observed for 11 hours but the youngest nestling could not be seen for the whole day, even when the adults came to feed them. In order to determine whether the smallest chick was missing, I climbed the tree and observed the nest from a high branch. The youngest chick was lying dead on the nest floor, while the two elder chicks sat quietly.

I could not go to the nest the next day due to continuous rain. A day later, I reached the hide at 0620 hrs and saw the dead nestling's body, which had started decomposing, dangling on the rim of the nest. A few minutes later, the male fed the two nestlings on what appeared to be dead bird material and was clearly not the usual food such as earthworms, amphibians or fish.

The adult male stood on the nest. When two house crows (*Corvus splendens*) tried to take the dead nestling, the adult successfully threatened them by raising the feathers of the head and foreneck, thus appearing very large.

At 0645 hrs the adult male started pulling at the head of the dead nestling, which was covered with a thick swarm of flies. Whenever the adult tried to pull it, hundreds of flies flew off with a buzzing sound. As the dead body of the nestling was entangled in the long sticks of the nest, it could not be pulled out. After some time, the female came with leaves of jamun (*Syzigium cumini*) and arranged them on the nest floor. In the meanwhile, the male flew away. The female also tried to remove the dead nestling and at 0759 hrs succeeded. The female immediately ate the head of the nestling. This confirmed that the dead bird fed earlier to the nestlings had been the dead chick. Soon the female left the nest. The male arrived at 0805 hrs with nesting material. At 0844 hrs the female again brought jamun leaves to the nest and arranged them on the nest, while the two nestlings begged for food. Almost immediately, she regurgitated the whole head on the nest floor, and it was immediately swallowed up by the elder nestling.

This may be a case of induced cannibalism and several factors could be responsible. For instance, if the adults had discarded the entangled dead nestling , it would have attracted predators such as crows and raptors. To avoid the chances of predation on other nestlings, the adult could have eaten it.

It is interesting that when the body was decomposing, the female began lining the nest with *Syzigium cumini* leaves which are strongly aromatic.

In the light of this case of cannibalism, previous observations are noteworthy. In July 1995, while monitoring the reproductive success of colonial breeders, I observed an openbill stork (*Anastomus oscitans*) throwing a less than one month old dead nestling out of the nest.

In January 1997, one juvenile woolly-necked stork and one juvenile of blacknecked stork (*Ephippiorhynchus asiaticus*) died in the nest at ages of 40 and 50 days respectively. In both instances the adults did not eat the dead juvenile. The bodies of the two juveniles decomposed in the nests.

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8. INDIAN SHIKRA PREYING ON SHORT-NOSED FRUIT BATS

While conducting a survey of small mammals as part of our EIA studies at the lignite mines of Neyveli, Madras during May-June 1996, we recorded an interesting observation on the Indian shikra, *Accipiter badius* feeding on short-nosed fruit bats, *Cynopterus sphinx.*

On the evening of 3rd June, we set six mist nets on the edge of the pond in the afforestation area of Mine I to collect the bats. At 1915 hrs we saw several bats emerging out of their roosts from the nearby forest and flying around the pond. The size of the bats prompted us to classify them as fruit bats, though the exact identification of the bats was not possible. The bats kept flying above the water for about half an hour, diving intermittently to sip some water, and finally they flew away. We did not succeed in catching any bats then. At about 2230 hrs. we saw bats coming to the pond once again and flying around. Again, there was no score in the nets. We left the nets overnight and returned to our camp.

The next day, at about 0630 hrs we saw eight fruit bats in the nets. We released them in the nearby bushes after identifying them as short-nosed fruit bats *Cynopterus sphinx.* As we were winding out the mist nets we saw one of the fruit bats rushing out of the bush and flying across the pond.

A crow was chasing the bat. As the chase was on, we saw a pair of shikra *Accipiter badius* emerging from another tree nearby, chasing the crow. While one of the shikras was chasing the crow, the other followed the bat which was flying above the pond in a zig-zag fashion. After a struggle of about 10 minutes, the shikra succeeded in capturing the bat. The pair returned to the tree and started feeding on the bat.

As we were winding out the last mist-net, we saw yet another bat coming out of the bush and flying above the pond. This time the second shikra of the same pair followed the bat and captured it within no time.

Shikra are known to feed on a variety of insects, lizards, small birds and mammals such as field rats, mice and striped squirrels (Ali and Ripley 1969). However, they have not been reported feeding on bats. This is the first instance of shikra feeding on the fruit bats.

The other birds of prey known to feed on bats are Indian black-crested baza, East Himalayan besra or sparrow-hawk, laggar falcon, shaheen falcon, Central Asian hobby, Indian hobby, red-headed merlin, Indian barn owl (Ali and Ripley 1969), brown hawk-owl (McCann 1933) and brahminy kite (Manakadan and Natarajan 1992).

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9. SIGHTING OF RED KITE *MILVUS MILVUS* AT RANIKHET

While surveying raptors at Ranikhet (29° 40' N and 79° 33' E) in the Kumaon Himalayas in Uttar Pradesh, we observed a solitary red kite *Milvus milvus* on 11th June 1994 soaring at about 200 m above ground level with black kites *Milvus migrans* over Chaubattia (2000 m). Even with the naked eye, it immediately appeared different and stood out clearly from the flock of black kites. On further scrutiny through binoculars and a telescope, we were able to confirm the diagnostic characters, especially with several black kites present for comparison. The slimmer outline, the more graceful, easy, agile flight (the twists and turns almost tern-like) and deep elastic wing-beats separated it from the Black Kites. It also appeared larger with longer and more angular wings in comparison with the black kite. Further, the longer, deeply forked rusty tail with blackish outer tips, appeared prominently translucent orange against the light. Its overall plumage was paler, brighter and more contrasting — a mixture of red-browns instead of dull browns as in the black kite. The whitish chin and throat, deeper chestnut body, and contrasting underwing (dark chestnut-brown underwing-coverts, prominent extensive white patch at base of primaries, black primary tips together with pale chestnut undertail with blackish outer tips) were clearly visible.

There are six published sight records of the red kite in India, mainly between January and March. Two from Gujarat in March — Little Rann of Kutch (Ali, 1954), and Jasdan (Shivrajkumar, 1964); two from Orissa — Chilka Lake and environs of Puri in January (Jayakar and Spurway, 1965); one each from Rajasthan — Keoladeo National Park, Bharatpur (Prakash, 1988); and Kashmir-Ladakh in July (Fily and Perennou, 1990). It has also been recorded from west-central Nepal in March (Rogers 1987, unpublished) where it was presumed a vagrant. The red kite does not differ significantly in habits from the black kite, being inclined to social aggregations in winter, and in most parts of its range, migratory during winter. Ripley (1982) describes it as a rare winter visitor to India. However, some authorities such as del Hoyo *et al.* (1994) dispute the occurence of the red kite in the Indian subcontinent and the entire Oriental Region. This note reviews the status of the red kite in Northern India, in view of the many scattered sight records by competent birdwatchers and ornithologists.

The distribution of red kite given by del Hoyo *et al.* (1994) is from south Sweden east to Ukraine and south through central Europe to west and central Mediterranean basin; Wales and the Caucasus. Its known or main wintering range appears to be well to the west of the Indian subcontinent. Russian authorities (Dementiev *et al.* 1966) have plotted its winter movements as far east as the Caspian in northern Iran. Vagrants do travel huge distances south, as shown by a ringed red kite from E. Germany recovered in South Afiica (Brown *et al.*, 1982), though it generally winters north of the Sahara in northwest parts of Africa. However, many experienced ornithologists are sceptical, especially of Ali's (1954) record of a large flock of 50 red kites in Kutch. Shivrajkumar (1964) observed both kite species perched on the ground close by for comparison, and his observation sounds convincing. The Orissa, Ladakh and Nepal records were confirmed by Dr. Bernhard Rensch, Christian Perennou and Mike Roger respectively, all of whom are well-known ornithologists, who are familiar with the species in Europe and the U.K. The verification of these various sight records has not of been done by this author, but successive records, by a range of experienced and skilled ornithologists adds credence to their reliability in most cases. It would be appropriate to presently treat the species as an irregular vagrant to the Subcontinent.

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10. ATTEMPTED BREEDING OF THE BLACKNECKED CRANE *GRUS NIGRICOLLIS* PRZEVALSKI IN NORTH SIKKIM

A small population of less than 10 blacknecked cranes *Grus nigricollis* Przevalski has been regularly visiting Lhonak valley in north Sikkim as far back as the local *dokpas* or Tibetan graziers can remember. Their numbers dropped down to less than five and the frequency of arrival decreased drastically with the occupation of the area by the Indian Army in the 1980s.

This information was first received during a trip to Green Lake via Lhonak valley in July 1990. The teacher at the only school in the valley at Muguthang village (4500 m) Mr. Lama Tsewang spoke of the 'tung-tung' and identified the species in the PICTORIAL GUIDE.

In July-August 1991, a pair of cranes was reported to have nested in Thepley Tso, a boggy marsh near Muguthang estimated to be *c.* 2-4 sq. km. This area is used intensively for livestock grazing by the *dokpas.* There is also one army unit and one local police unit permanently posted in the area. After several days, due to biotic interference, the pair abandoned the nest.

I visited Muguthang in July 1992, following news of the arrival of the cranes and surveyed the whole area for four days where cranes were reported circling but not landing. They had left by the time I arrived. On December 6, 1992 a pair of cranes with one juvenile was reported from Muguthang, but as it takes three days to reach the area, I could not get there on time.

Upto August 1996, I have extensively explored the trans-Himalayan region in Sikkim but found evidence of breeding of the blacknecked crane only in Muguthang.

Three cranes arrived once again on May 29, 1996. The village *Pipon* or headman sent me a letter which took 16 days to reach Gangtok from north Sikkim. A wireless message was immediately sent to the army and police units to keep track of the birds. A reply was received from the Sikkim Police that the birds had left after 10 days and did not return. Yet another chance to see the rare birds was lost.

Lhonak valley is perhaps one of the richest areas in Sikkim as far as trans-Himalayan avifauna, mammals and medicinal parts are concerned. The whole area is cut off from the outside world during winter when the Lungnak La, the only entrance to the valley gets snowed in. The entire area was explored from Lungnak La upto the north and souther Lhonak glaciers, the base of Chorten Nyima La, Khora area, Naku La and right down to the Zemu Glacier and Green Lake.

There is a good breeding population of the ruddy shelduck *Tadorna ferruginea* and the common redshank *Tringa totanus*. Four avocets *Recurvirostra avosetta* were also seen at Tso Chik at the base of the Chorten Nyima La. Himalayan marmot *Marmota bobak,* woolly hare *Lepus oiostolus* and *Ochotona tibetica* (?) are the most easily seen mammals. Jatamansi *Nardostachys grandiflora*, and juniper *Juniperus prostata* are the most intensively collected medicinal plants. The entire area is a rich storehouse of wild genetic material as well as an important flyway for migratory waterfowl (Ali, 1962).

Lhonak Valley in north Sikkim has the potential of a good breeding ground for blacknecked cranes, one of the rarest cranes in the world ,with the most restricted area and the prestige of being the only area in India other than Ladakh to support the species.

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11. THE BENGAL FLORICAN *EUPODOTIS BENGALENSIS* GMELIN 1789 IN DIBANG VALLEY DISTRICT OF ARUNACHAL PRADESH

(*With one text figure*)

On 3 March, 1993, I observed a male and two widely separated females of the rare Bengal florican *Eupodotis bengalensis* near Bomjir, in Dibang Valley dist., Arunachal Pradesh (28° 07' N, 95° 42' E). The habitat type was short grassland with thatch grass (*Saccharum* sp., *Imperata cylindrica*) on a *chapori* (riverine tract and islets) of the Dibang river. The male was flushed at 1605 hrs from near a cattle camp and flew to about 200-250 metres to a fairly tall patch of grass (*c.* 2 m high). While looking for this male in the tall patch of grass, we flushed two females about 100 m apart. They flew to about 300 m and settled in different areas of the grassland.

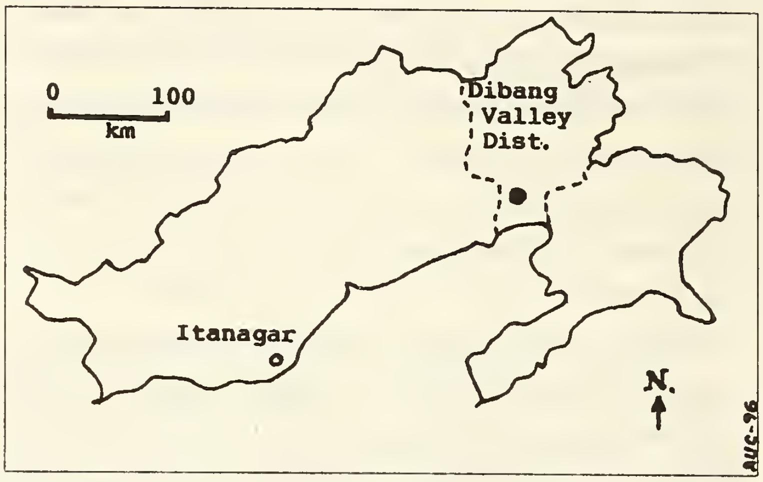

Fig. 1. Map of Arunachal Pradesh showing location of Dibang Valley District and the locality of florican sighting (●).

In Dibang Valley dist., the floricans are found mostly in Dibang Reserve Forest (RF), especially in the eastern and southern areas where grassland is the dominant vegetation. They are also found in the southern areas of Sirkee (proposed) RF. Stray floricans are reported from the grassland in the western areas of Kerim RF, adjacent to Dibang RF. A few occasionally wander north upto Nizamghat, following the grassy *chaporis* of the Dibang river-bed. Nizamghat is near the spot where the Dibang river debouches onto the plains.

Dibang Valley was not covered by other recent surveys (Rahmani *et al.* 1991). Hume and Marshall (1880) confirmed the occurrence of the species in this area. The hilly areas of Dibang Valley are known as Mishmi Hills.

Dibang RF is threatened by encroachment and subsequent regularisation of such encroachments through de-reservation. Already about 100 sq. km have been de-reserved out of a total area of 303 sq. km. Considering its importance for the Bengal florican, white-winged wood duck *Cairina scutulata,* and a final staging area of the migrating common cranes *Grus grus,* an area of 202 sq. km including parts of Dibang RF, Kerim RF and Sirkee proposed RF have been recommended for a National Park (Choudhury 1996).

I thank Leto Mili, Nur Hussain and Dilip Handique for their help in the field.

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12. SIGHT RECORD OF THE ORIENTAL BAY OWL (*PHODILUS BADIUS RIPLEYI*) IN THE ANAIMALAI HILLS, SOUTHERN WESTERN GHATS, INDIA

The Oriental Bay Owl is a rare and little known inhabitant of the wet evergreen forests of south and southeast Asia (Ali and Ripley 1983). Three subspecies are known from Indian limits: (i) the Sikkim Bay Owl *P. b. saturatus*, (ii) the Peninsular Bay Owl *P. b. ripleyi,* and (iii) the Ceylon Bay Owl *P. b. assimilis* (Ali and Ripley 1983). The peninsular race of the owl was discovered and described by a single specimen from Periasolai in the Nelliampathy hills of Kerala, south of the Palghat gap in wet evergreen forest (Hussain and Khan 1978). It was rediscovered in 1992 in the Indira Gandhi Wildlife Sanctuary, Anaimalai (Kannan 1993). Another recent report of the bird was from rubber estates near Kannur in Kerala (R. Kannan, *pers. comm.*).

Here, I report a sighting of the Oriental Bay Owl in the Indira Gandhi Wildlife Sanctuary, Anaimalais. A single bird was sighted on May 11 1996, in Karian Shola National Park. It was seen at 1515 hrs and could be clearly observed for about 15 min, while it perched in a large gaping hollow of an *Elaeodendron glaucum* tree about 9 m above the ground. The bird was observed by Natarajan, a local tracker, and myself in an area close to where the bird was earlier located by Kannan (1993). Careful documentation of the distribution of this rare bird is imperative in the face of threats to its remnant rainforest habitats in south and south-east Asia.

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13. UNEVEN SEX RATIO OF THE LONG-EARED OWL *ASIO OTUS* IN NORTHERN INDIA

The long-eared owl *Asio otus* is a holarctic species breeding north to the boreal zone. In the Indian subcontinent, it winters south to Sind, Lahore and central Nepal, breeding in north Baluchistan and Kashmir, and summering in Gilgit (Ripley 1982). Ali and Ripley (1983) report it upto Delhi, Kutch and Nepal.

In Europe, unequal sex ratios of migrant long-eared owls have been reported from Great Britain and Sweden. In Great Britain, female bias exists among migrants on Fair Isle (Harvey and Riddiford 1990) and wintering birds throughout Britain (Wyllie *et al.* 1996, Williams 1996). In Sweden, male bias exists among wintering birds in the mainland (Overskraug and Kristensen 1994), although a non-significant female bias exists in a small sample of birds wintering on the island of Skåne (Williams 1996).

Long-eared owl skins from the Indian subcontinent (mostly from Punjab) in the British Museum of Natural History (Tring) were examined. Only those sexed by internal examination when collected and labelled were analysed. The criteria for sexing long-eared owls on plumage characters exist (Williams 1996), but were designed for birds in western Europe. Geographical plumage variation can be greater than that between the sexes, invalidating its use for birds from the Indian subcontinent. The collection contained 44 birds sexed through internal examination, 10 males and 34 females, a skewed sex ratio which differs significantly from unity (Log-likelihood test: G=13.83, 1 df, P<0.001). This ratio, in favour of females, parallels the situation in Great Britain and is the result of different migration between the sexes from northern breeding areas. Whether the migrant long-eared owls wintering in the Punjab are from the Himalayan foothill population, long distance migrants from north of the Himalayas, or a combination of both, is unknown.

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14. NEST USURPATION IN WOODPECKERS

Short (1979) has discussed in detail about the competition for nest cavities in woodpeckers which lose their nest cavities to secondary cavity nesters or even to woodpecker species larger than themselves. He also discusses the strategies adopted by them to avoid the loss of nest cavities.

During my study of woodpeckers at the Peechi-Vazhani Wildlife Sanctuary, Kerala, I came across an instance of nest usurpation. The loser was the Mahratta woodpecker (*Picoides mahrattensis*). the female bird was first noticed on 23 January 1992, excavating the trunk of a live *Eucalyptus* tree, 3.35 m from the ground. The trunk measured 22.9 cm in diameter at nest height. The male bird was also noticed excavating the same site later the same morning. I had earlier seen this pair excavating, and later abandoning, two other holes on *Eucalyptus* trees. Excavation continued until the second week of February. In the last week of February, as there was no activity at the nest, I took a closer look and found a broken egg shell being removed by ants. Three days later, I saw lesser goldenbacked woodpecker (*Dinopium benghalense*) flying from the nest tree. Over the next month, the goldenbacked woodpecker pair enlarged and excavated the nest cavity. The bird must have laid eggs, as I found the bird inside the cavity quite a few times, as I went past the tree. I was not able to follow the outcome as I had to follow up other nests.

It is possible that the Mahratta woodpecker lost its eggs due to the usurpation of its nest cavity by the pair of lesser goldenbacked woodpeckers. I had seen the latter species close to the nest even when the Mahratta woodpecker nest was active. The goldenbacked were tempted to usurp the nest because the nest site was on the trunk of a tree with adequate girth to meet their requirements. Smaller woodpeckers normally nest in smaller substrates (trunk/branch), thereby reducing the possibility of a take-over by their larger counterparts. The mean DNH (diameter at nest height) size of the Mahratta woodpecker nests is 17.5 (± 3.91) cm while it is 28.3 (± 9.66) cm for the larger species (Santharam 1995). But in this case, as the nest was on a larger substrate, it was successfully taken over by the lesser golden-backed woodpeckers.

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February 26, 1997

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15. SPECKLED PICULET *PICUMNUS INNOMINATUS* AND GOLDEN SPECTACLED FLYCATCHER-WARBLER *SEICERCUS BURKII* FROM MARGALLA HILLS, PAKISTAN

Between January and March 1995, we made a series of visits to the Margalla Hills on the outskirts of Islamabad, Pakistan. On the morning of 27th February two species noted by Roberts (1991, 1992) as being "extremely rare and local" in Pakistan were observed.

Speckled Piculet *Picumnus innominatus*

This species is found mainly in the foothills from Afghanistan, through India, Bangladesh, Malaysia, and southwestern China (Roberts 1991). The species is extremely rare in the northwestern-most part of its range (Winkler *et al.* 1995). Roberts (1991) states that the species is very local in Pakistan, citing just a few records.

Roberts (1991) reports that despite intensive fieldwork in the Margalla Hills for the past 20 years the species has only been recorded twice, with records in July 1977 and April 1982. Since then, there has been one additional record of a single male on 11th May 1994 (Benstead *et al.* in press).

We located a single female speckled piculet at *c.* 600 m on the edge of a clearing in deciduous secondary woodland. The bird, first located by its agitated chattering call, was observed for ten minutes at a range of 10-20 metres. The bird was watched foraging on slim branches and the trunks of saplings, allowing close approach. Although Roberts (1991) and Winkler *et al.* (1995) note that outside the breeding season speckled piculets often join mixed flocks, this bird was entirely alone.

This sighting, together with previously documented records, suggests that the Margalla Hills may support a small population of speckled piculets at low density. Winkler *et al.* (1995) suggest that the species is often overlooked due to its unobtrusive behaviour.

Golden Spectacled Flycatcher Warbler *Seicircus burkii*

This species occurs widely in southeast Asia (Roberts 1991), being found from south China, through Cambodia, Laos, Myanmar, Thailand and across the Himalayas, but is on the western extremity of its range in Pakistan.

Roberts (1992) states that the species is extremely rare in Pakistan, citing just five records, two of which come from the Margalla Hills in winter and spring. We located an individual in dense woodland at *c.* 650 m, foraging in dense undergrowth close to the ground.

ACKNOWLEDGEMENTS

We would like to thank Phil Benstead for his comments on a draft of this note.

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16. BREEDING OF SOUTHERN JUNGLE MYNA *ACRIDOTHERES FUSCUS MAHRATTENSIS* (SYKES) AT KARANJA

On 20th April 1996, a group of southern jungle mynas *Acridotheres fuscus mahrattensis* was seen at Karanja near Uran, Raigad dist., Maharashtra, on and around a huge 800 year old baobab tree *Adansonia digitata.* By the first week of May, many of them began nesting in holes at different heights, ranging from 5-10 m in the same tree. In June, when we visited the site, males (probably) were bringing food to the females and to the chicks sitting inside the nests. We did not want to disturb the birds by probing their nests, but noticed a long ribbon of audio cassette tape hanging from one of the holes, presumably used inside the nest. Sálim Ali and Humayun Abdulali (1941) reported them using onion peel, snake-slough or tissue paper, may be tapes were not available those days! In the 3rd week of September all the holes except one were appropriated by nesting roseringed parakeets. In one hole, a Myna was still feeding the inmates. On 5th October, when we visited the place, jungle mynas were quite absent and there was an over-abundance of common mynas. On 29th March 1997, jungle mynas (10-12) were examining the holes in the same baobab tree and were singing.

Sálim Ali and Humayun Abdulali (1941) in their book "The Birds of Bombay and Salsette" term the status and distribution of this myna as curious and inexplicable. The jungle myna has a patchy distribution, even though it is as common as the common myna at Kihim and Thane. Except for one or two stray records they are not sighted in Mumbai. Sálim Ali (1935) reported a similar peculiarity in the local and patchy distribution of the jungle myna in Kerala. Nayan Khanolkar and Adesh Shivkar (pers. comm.) reported that jungle mynas were common at Dombivli, Thane dist. from Aug-Jan and only occasionally seen during the breeding period. They seem to be local migrants and at Karanja they come only to breed, and leave thereafter.

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17. GECKOS AS FOOD OF MAGPIE ROBIN

On 2 August 1995, I was watching birds in the courtyard of my bungalow in Morena, north Madhya Pradesh, when my attention was caught by a wriggling gecko in the mouth of a magpie robin (*Copsychus saularis*). The rain had stopped half an hour earlier after a very heavy downpour. The gecko that was probably weak after enduring the rain, was caught by the bird, that ripped open its stomach. The sub-adult gecko died soon. The bird jerked it to take out the softer inner parts.

Soon a fledgling magpie robin descended from a tree on to the wet ground, and the male parent began to feed it with the softer inner organs of the gecko. From the skin, the gecko was identified as Brook's gecko (*Hemidactylus brooki*).

Earlier, in a similar incident on 26 July 1995, a magpie robin was seen to feed on a dead northern house gecko (*H. flaviviridis*).

The magpie robin normally feeds on insects picked off the ground and flower nectar. These two species of gecko are recorded here as the food of this bird.

February 27, 1997

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18. RANGE EXTENSION OF WHITE WAGTAIL *MOTACILLA ALBA LEUCOPSIS* AT POCHARAM LAKE, MEDAK DISTRICT, ANDHRA PRADESH

On 12th January 1997, we visited Pocharam Lake, 18° 8' N, 78° 10' E (part of Pocharam Wildlife Sanctuary, Medak dist. Andhra Pradesh), to count waterfowl for the Asian Waterfowl Census. For this purpose, we sat on the eastern shore of the lake, approximately 15 m from the edge of the water. The shore was covered with grass stubble, a few *Prosopis* bushes, and littered with small stones and broken boulders. Among the various species of birds present on this narrow strip of land between the water's edge and us, we noticed what seemed like two different races of the white wagtail *Motacilla alba.*

On closer examination through binoculars and telescope, we confirmed that there were indeed two races of the white wagtail, quite clearly distinguishable from each other by the differences in their plumage. One was identified as either *Motacilla alba dukhunensis* or *M.a. baicalensis.* Two specimens of the former race have been collected in Andhra Pradesh earlier (Ali and Whistler 1932, Majumdar 1984), and so it is possible that these birds were *dukhunensis.* though there is nothing to prevent from being *baicalensis,* as both are indistinguishable from each other in winter. However, there is no record (specimen) of *baicalensis* from South India (S. Unnithan 1997, Bombay Natural History Society, *in litt*).

The other race in question could be identified with more conviction and accuracy. There were two birds with a black back, black cap, white forehead, white sides of head and neck (including the lores region) and a black bib. The only two races which have a black back are *M. a. alboides* and *M. a. leucopsis* (Ali and Ripley 1987). The former has black ear-coverts, and the latter white ear-coverts. The birds we saw certainly *did not have black ear-coverts* (a sketch was made in the field). This is, therefore, an extension of the known range of this race, which is reported from N.E. India, with the western most record from eastern Uttar Pradesh and also Andaman Islands (Ali and Ripley 1987). The possibility also remains that they are spread over a much larger area all the time, but have been overlooked as just another "White Wagtail"!

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19. WHITE-EYE (*ZOSTEROPS PALPEBROSA*) FEEDING THE CHICKS OF PARADISE FLYCATCHER (*TERPSIPHONE PARADISI*)

We were birdwatching near Udaipur on 13th July, 1996. At 0930 hrs we found a nest of paradise flycatcher (*Terpsiphone paradisi*) on a bare branch of a mango tree (*Mangifera indica*). We observed the birds from a distance of about 15 m from the nest, behind some bushes. There were four chicks in the nest and both the male and female were feeding their nestlings. Soon we saw that on a leafy part of the same branch, two white-eyes (*Zosterops palpebrosa*) were darting in and out of the leaves. We found the nest of the white-eyes about 2 m from the nest of the paradise flycatcher on the same branch.

At 1015 hrs, the frequency of feeding by the paradise flycatcher slowed down. Both the birds flew away, out of the vicinity of their nest. At this juncture, one of the white-eyes came and perched on top of the nest of the paradise flycatcher. The chicks raised their necks with wide open beaks and begged for food. The white-eye fed the chicks, or at least was seen to put its beak into the mouths of two nestlings. When the chicks calmed down, the white-eye started feeding on the nest material of the paradise flycatcher's nest. The rocking of the nest agitated the chicks and the white-eye once again calmed them down by putting its beak in the mouth of the chicks.

It remained on the nest for three minutes and then flew away.

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20. SHORT TAILED AGAMA IN SOUTHEAST RAJASTHAN

A small lizard was caught on 25 December 1994 from Sorsan Bustard closed area in Baran dist. in southeast Rajasthan. On a warm afternoon in winter, it was scurrying from one jujube bush to another. The lizard was caught and measured. Its total length was 85 mm, of which 37 mm was tail and 48 mm snout to vent length. It had a triangular head, a well defined neck and upper body varigated with dark brown irregular lines and circular spots along the spine. The ventral surface was pale with faint brown lines on the lower jaw and belly. Front and hind legs had five digits each. The lizard was collected and photographed (BNHS Regn. No. 1434). It was identified as short tailed agama *Agama minor* Hardwicke & Gray by Mr. J.C. Daniel. The specimen has been deposited in the BNHS Collection, Reptile section, Regn. No. 1434.

THE BOOK OF INDIAN REPTILES (Daniel 1983) mentions the short tailed agama as a widely distributed species in the Gangetic plains and central and western India. Yet *Agama minor* does not find a place in the reptilian fauna of Rajasthan (Sharma 1995). Sharma also informed the authors that he has not found it during his surveys in Rajasthan (pers. comm.). Thus our finding of *Agama minor* in a dry grassland in southeast Rajasthan is extremely important and it is probably the first report from this region.

We thank Mr. J.C. Daniel and Dr. S.K. Sharma for their help in identification and literature.

April 6, 1998

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21. THE BREEDING OF THE INDIAN ROCK PYTHON (*PYTHON MOLURUS*) IN MUDUMALAI WILDLIFE SANCTUARY, TAMIL NADU

The Indian rock python (*Python molurus*) is widely distributed in India, although little information is available on its breeding habits (Acharjyo and Mishra 1976; Daniel 1983; Dattatri 1990; Bhupathy 1993). This note describes my observations on the breeding habits of the Indian rock python in Mudumalai Wildlife Sanctuary (MWS).

There are remnants of several abandoned buildings which were constructed by the British Army during World War II near Kargudy Guest house in MWS. On 10 April 1996, an adult python was entering one such construction: a damaged underground septic tank. The tank was very shallow (around 0.5 m depth) and there was a small cavity on the side wall of the tank into which the python entered and coiled itself. The python was visible only partially from outside. The next day, on closer observation, we saw some eggs around which the python was coiled. Since the cavity was small, we were unable to count the number of eggs. We visited the place regularly and recorded the presence of the python. The python was observed incubating the eggs till 2 June. On 3 June, when we inspected the place, we saw nine python hatchlings moving around the egg mass which was inside the cavity, but the adult python was not to be seen. A day later, one of the hatchlings, which measured 65 cm in length, was found dead. The cause of death could not be ascertained. The remaining eight hatchlings moved away from the tank within the next four days. Later, when all the hatchlings moved off from the place, we removed the egg mass from the cavity and counted 46 eggs. Out of 46 eggs, only nine had slit-like openings indicating hatching.

The egg laying season we recorded (April) is slightly earlier than that reported in Keoladeo National Park, Bharatpur, Central India (Bhupathy and Vijayan 1989, Bhupathy 1993) and North India (Smith 1945). This could be due to environmental reasons. The incubation period estimated by us was fifty-three days (from 12 May to 3 June). This is similar to that reported earlier, 58 days (Daniel 1983) in the natural condition and 55 to 60 days (Dattari 1990) in captivity. Our observation further confirms the statement of Daniel (1987) that the mother leaves the eggs soon after hatchlings emerge.

We thank the Forest Department of Tamil Nadu for permission to work in the Mudumalai Wildlife Sanctuary. We also thank Dr. S. Bhupathy, Sálim Ali Centre for Ornithology and Natural

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22. RAINBOW TROUT (*SALMO GAIRDNERII*) IN ANAIMALAI HILLS, WESTERN GHATS

The rainbow trout *Salmo gairdnerii* is an anadromous fish like Salmon. It was introduced in India from United Kingdom, New Zealand and Sri Lanka in 1869 (Talwar and Jhingran 1991). The first attempt to import trout eggs and fry from abroad was made in 1863 by Francis Day (Jhingran and Sehgal 1978).

Introduction of trout into Kerala and its present status

Introduction of trout into Kerala dates back to 1909 when eyed-eggs of *Salmo trutta fario* were brought from the United Kingdom. A hatchery was made at Kanniamallay estate for brown trout. But these efforts met with little success, hence efforts to introduce brown trout were given up in Kerala in favour of rainbow trout. A rainbow trout hatchery was established in 1941 at Eraviculam. Another hatchery at Rajamalai was established to meet the demand for the Maddupatty and Kundally reservoirs, Elephant and Devikulam lakes, Kadallar, Pettimudi and Rajamalai streams. The management of trout fishery through hatcheries and its introduction in reservoirs and hillstreams was controlled by the High Range Angling Association, Munnar. In 1943, Dr. Freeman transplanted rainbow trout fingerlings in the Konalar streams, near Valparai, Tamil Nadu from Munnar High Range zone, Kerala (Jhingran and Sehgal, 1978). In 1939, trout hatchery management and stocking of the streams with trout achieved great success in Munnar. Molesworth and Bryant (1921) and Mackay (1945) reported their findings on trout in Travancore and the Nilgiris. After that there is no literature on the culture or natural occurrence of trout in Anaimalai.

The Rainbow trout *Salmo gairdnerii* is now well established in streams and rivers of Munnar and Valparai. Last year, a survey was conducted in the Anaimalai hills which confirmed the occurrence of *S. gairdnerii* in the wild. During our survey we were able to collect three specimens of average SL 20 cm. from Konalar stream, in the sholas (hilly grassland) of Anaimalai hills near Valparai; two specimens each from Eravikulamar and streams flowing through Kannandevan tea estate (SL 12 cm). From the Konalar stream, the only species recorded was *Salmo gairdnerii.* According to W.S.W. Mackay, all our streams including the Eravikulam were, before the advent of the rainbow trout, full of an indigenous fish *Glyptothorax madraspatenus.* This species was not obtained in our collections. But from Munnar we have recorded a few fry of genus *Garra* and *Puntius melanampyx* along with trout. Our collection sites were located at an altitude between 1300 and 1950 m above msl and the temperature ranged from 12°-20° C.

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Ed: In addition to the references given above, other useful references are comments by Francis Day in "Fishes of India"; also "History of transplantation and introduction of fishes in India", by S. Jones & K.K. Sarojini (1952) *JBNHS* 50(3): 594-609; and Day, F. (1876) On the introduction of trout and tench into India. *J. Linn. Soc.* 1876: 562-565.

23. *SICYOPTERUS GRISEUS* (DAY) FROM PERIYAR RIVER, KERALA

The fish *Sicyopterus griseus* (Day) inhabits torrential streams, and its general body form and structure of lips, rostral fold and pelvic fins are well adapted for combating strong currents. It is stoutly built, with the head and the anterior part of the body slightly depressed, while the tail is compressed. The eyes are situated dorsolaterally in the anterior part of the head. The inter-orbital space is broad and slightly concave. Mouth nearly horizontal; lower margin of upper lip with short papillae. The anterior lip is covered by the rostral fold which is broadly fimbriated. Scales of head and nape are cycloid, smaller than those in the middle of the body, about 80 scales in longitudinal series.

This fish is fairly common in the Madras backwaters (Talwar and Jhingran, 1991). Hora (1941) reported its range extension to Travancore. He redescribed the species from the collection taken by Dr. S. Jones on 8th June 1941, from the Kallar stream, 48 km northeast of Trivandrum. Since 1941, there was no report on this fish from any river in Kerala.

On 12th June 1997, we collected a single specimen of this species from Kalady, Periyar river, Kerala. Its habitat was characterised by the presence of pebbles and boulders along with sand at the bottom, 50 m above msl. The importance of this report is that it was the first time after an interval of 56 years that this fish has been rediscovered but from a different river system in Kerala. During these intervening years several surveys have been conducted in various river systems in Kerala, it was not reported. Jones obtained only 5 specimens from the Kallar stream, while we too could collect only a single specimen from the collection site. This suggests the rarity of the species in the fresh waters of Kerala. Moreover, as per the standard followed by IUCN for determining the status of the fish, this species can be considered as Rare as it is located within a very restricted geographical range in Kerala. It can also be considered as Endangered because of the drastic reduction in its number from wherever it had been captured. This species was not familiar even to the local fishermen. Based on our study, we feel that special efforts should be made to save this species from extinction.

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February 14, 1998

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24. A NEW RECORD OF *HOMALOPTERA MODESTA* (VINCIGUERRA): CYPRINIDAE FROM MANIPUR

During our study on the fresh water ichthyofauna of Ukhrul dist. Manipur, two specimens of *Homaloptera* were collected from Namyak, a small stream originating in the foothill of Kongkanthana, which flows for about 3 kms in the Indian region and then into Myanmar and directly joins the Chindwin drainage. Homalopterine loaches inhabit quick flowing waters of the Oriental region and are characterised by a flattened head and body, horizontally oriented enlarged paired fins bearing adhesive pads covered with urculi on the ventral surface, that help them to live in mountain streams and rivulets (Kottelat, 1988).

The genus *Homaloptera* Van Hasselt is represented by four species, viz., *H. rupicola* Prasad and Mukherji, *H. modesta* Vinciguerra, *H. montana* Harre and *H. bilineata* Blyth. Only *Homaloptera montana* Harre was recorded in India, the other three are found in Myanmar and Thailand. The present specimen agrees with the original description (Vinciguerra 1890) in morphological appearance and meristic counts. This note reports the species for the first time from India and a detailed account of morphometric characters of the fish based on two specimens is presented here.

The fish was collected by poisoning and side-tracking of streams. Specimens were preserved in 10% formaline. The type specimen is deposited in Manipur University. Meristic counts and morphometric measurement follow the standard key of Jayaram (1981). The body proportions are expressed as a percentage of standard length (SL) and head length (HL).

Homaloptera modesta Vinciguerra

Hegia modesta Vinciguerra, 1890, *Annali. Mus. Civ. Stor. Nat. Giacoma doria,* (2) 9: 330, pl. 2, fig. 12 (Type locality: Meekalan and Meetan, Lower Myanmar)

Homaloptera modesta: Silas, 1953, *Rec. Indian Mus.* 50 (2): 194.

TABLE 1
COMPARISON OF *HOMALOPTERA MODESTA* (VINCIGUERRA) OF NAMYAK STREAM, MANIPUR WITH THAT OF MEEKALAN AND MEETAN, LOWER MYANMAR (MENON 1987)

Characters	Namyak Stream Manipur, India	Meekalan and Lower Myanmar (Menon 1987)
in % of SL		
Body depth	15.08-15.71	12.50-14.29
Caudal length	24.12-26.57	15.00-21.43
Head length	25.54-26.80	25.0-28.57
Predorsal length	50.93-53.77	50.00-54.76
Dorsal fin height	19.70-23.71	—
Pectoral fin length	27.61-30.65	25.00-34.8
Pelvic fin length	20.00-21.89	20.00-23.81
Anal fin height	16.62-17.42	16.67-17.50
Prepelvic distance	45.84-49.84	45.00-50.00
Pre-anal distance	74.79-79.42	75.00-83.33
Pelvic to anal	28.95-32.05	—
Ventral to anal	5.89-6.80	—
Snout length	12.06-13.14	12.50-14.29
in% of HL		
Head width	75.00-76.92	60.0-75.0
Head height at occiput	48.00-51.64	50.00
Eye diameter	22.85-24.17	33.33-40.00
Inter orbital space	28.00-32.38	—
Pectoral length	100.13-100.3	—
Snout length	45.00-50.54	50.00

Homaloptera modesta Menon, 1987, *Fauna of India,* Pisces, 4: 223.

Material examined: MUMF/1090, 41.1 mm standard length. MUMF/1091, 37.3 mm SL. Namya stream, coll. Selim Keishing 25.iv.1995.

Description: D ii, 7; P v, 8; V ii, 6; A ii, 7; C 18; L. l. 47-48. Body subcylindrical, ventral surface flattened. Head depressed, but not flattened, snout long and pointed. Mouth small, inferior, slightly arched, fringed by thick plain lips, continuous at angle. Labial groove widely interrupted; barbels short and stout. Eyes moderately large, dorso-lateral, situated in the posterior half of the head, not visible from the ventral side. Dorsal fin short, commencing behind pelvic fin; its origin nearer tip of snout than base of caudal fin. Pectoral fin separated from pelvic by a short distance. Pelvic shorter than pectoral, extends half way to anal. Scales small, absent on the head and chest. Caudal fin deeply emarginate.

Proportional measurements of *H. modesta* Vinciguerra are as follows (in percentage): Body depth 15.08-15.71; Caudal length 24.12-26.54; Head length 25.54-26.80; Predorsal length 50.93-53.77; Dorsal fin height 19.70-23.71; Pectoral fin length 27.31-30.65; Pelvic fin length 17.15-21.89; Anal fin height 16.62-17.42; Prepelvic distance 45.84-49.84; Pre-anal distance 74.79-79.42 in standard length. Head width 75.00-76.92; Head height at occiput 48.00-51.64; Eye diameter 22.85-24.17; Inter-orbital space 28.00-32.38; Pectoral length 100.13-100.30; Snout length 45.00-50.54 in head length.

Colour: Back and sides with numerous irregularly disposed black and brown spots of various sizes and shapes. Fins barred with black.

Distribution: India: Namyak stream at Ukhrul dist. Manipur. Myanmar: Meekalan and Meetan, lower Myanmar.

Discussion: The present specimens agree with the original description of the species from Meekalan and Meetan, Lower Myanmar described by Vinciguerra (1890). It is a small Homalopterine loach which is well adapted to torrential hill streams. The total length of *H. modesta* in our collection ranges from 37.3-41.1 mm in SL. The species has five well developed adhesive undivided pectoral fin rays. It differs from *H. rupicola* in its dorsal insertion being nearer the tip of the snout than the base of the caudal fin and lateral line with 47-48 scales. Though slight differences can be seen from meristic counts and morphometric measurements viz: head width, caudal length, eye diameter, snout length etc, these differences are too small to create a new species. The differences may be due to changed ecological condition. The counts of the present specimen fall within the range for the species and we thus identify the present specimen as *H. modesta.*

The species is mostly found in torrential fresh water bodies of the Oriental region. Four species of the genus *Homaloptera* are found in India, Myanmar and Thailand. The present species was originally known from Myanmar and Thailand. The occurence of *H. modesta* in Namyak stream might be due to its connection with Chindwin Irrawady system of drainage. This report extends its distribution to the Chindwin river system of Manipur, India.

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25. FINAL INSTAR LARVA OF *ISCHNURA AURORA AURORA* (BRAUER) (ZYGOPTERA: COENAGRIIDAE)

(*With seven text-figures*)

The final instar larvae of two species of Genus *Ischnura* Charpentier, 1840 are already described from India (Kumar 1973). Literature on Indian dragonflies (Kumar 1973, 1985; Kumar and Prasad 1985) revealed lack of information on the larva of *Ischnura aurora aurora* (Brauer, 1865). Therefore I studied the morphology of larva of *I. aurora aurora.*

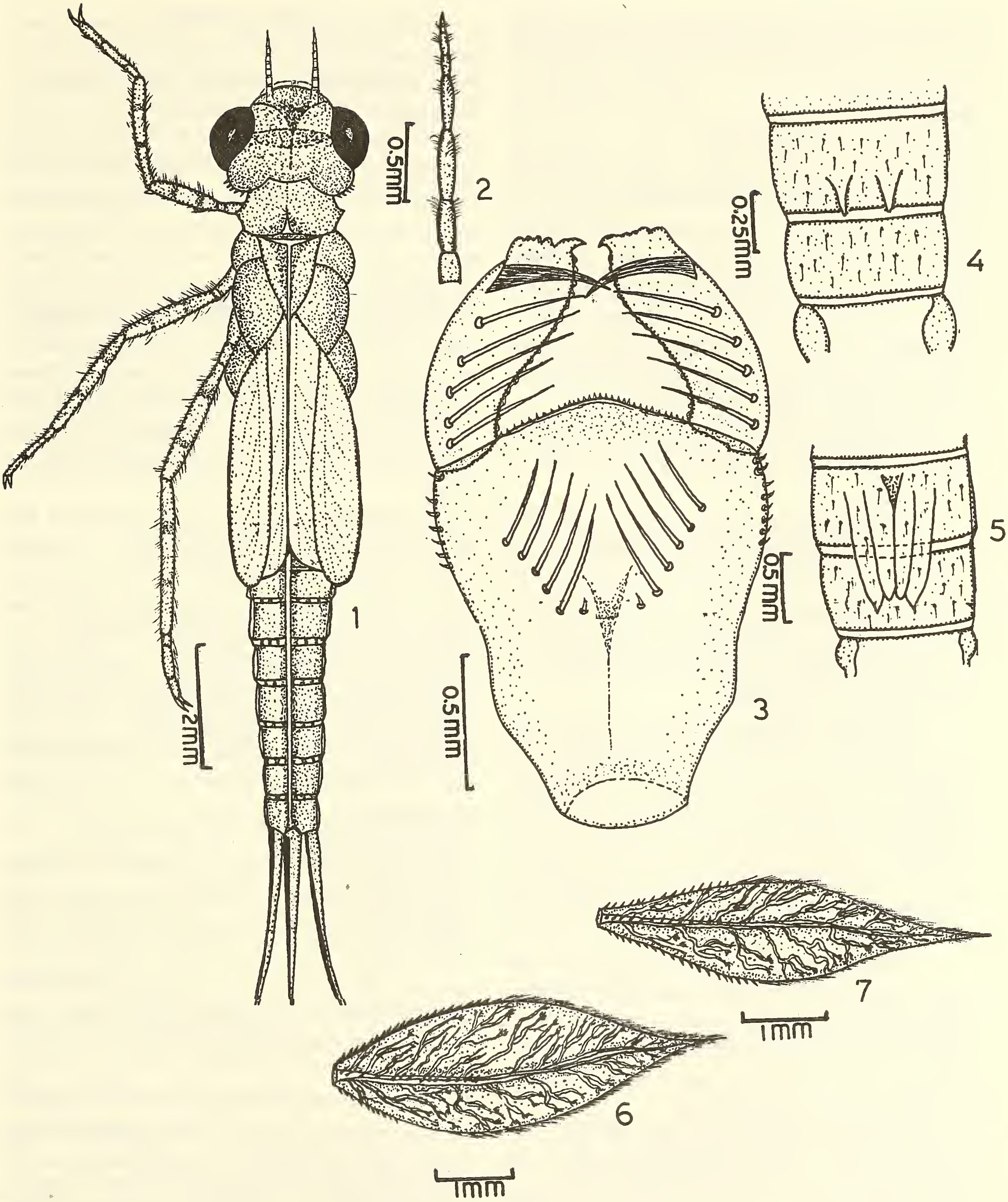
Material: India: M.P., Sagar, at 23° 52' N and 78° 45' E, Gwalla mohalla village, 10.ix.1982 (15 males, 6 females) from a narrow hill stream, Dharmashri village, 18.ix.1982 (6 males, 3 females) from a narrow stream. All larvae were reared in the laboratory.

Description: Total length (antenna excluded) 13.50 - 15.50 mm; X 14.42 mm; width of head 2.80 - 3.05 X 2.88 mm; all measurements are the mean of 30 larvae. **Colouration**: Males greenish yellow and females yellow mottled with black granules. Ventral surface brown in male and female. Caudal lamellae pale brown.

Head: (Fig. 1) Triangular with round anterior margin and deeply concave posterior margin. Lateral sides bulging out and provided with dark brown setae.

Antenna: (Fig. 2) filiform; measurements (in mm) of segments being 0.17, 0.28, 0.42, 0.26, 0.18, 0.15 and 0.10, total length 1.56 mm. Eyes steel grey, 1.0 mm x 0.62 mm. Ocelli not visible.

Labium: (Fig. 3) extending posteriorly up to the fore coxae. Prementum as long as wide. Lateral margins of prementum with a few spiniform setae. Distal margin of prementum convex and provided with a few small claviform setae. Premental setae formula 5_1 & $^{1}5$, palpal setae 5 & 5, distal margin of palpus divided into


1
2
3
4
5
6
7
0.5mm
0.25mm
0.5mm
0.5mm
2mm
1mm
1mm

Figs. 1-7: *Ischnura aurora aurora* (Brauer) structural features of the final instar larva: 1. Final instar larva; 2. Antenna; 3. Labium; 4. Male gonapophyses; 5. Female gonapophyses; 6. Median caudal lamella; 7. Lateral caudal lamella.

two lobes, outer lobe bearing 4 distinct teeth, while the inner terminates in a sharp end-hook. Movable hook stout and half the length of palpus.

Thorax: Collarshaped. Each wing bud measures 3.40 mm in length; hind-wing buds extending posteriorly to the middle of the 4th abdominal segment. Legs with two dark brown bands each on femur and tibial region; the fore, mid and hind legs measuring 3.59 mm, 4.86 mm and 6.00 mm respectively. Tibial comb mainly comprised of scattered tridentate setae and some long setae. Tarsi three segmented, with double row of pectinate setae.

Abdomen: Cylindrical with middorsal strip pale brown, extending through the length of abdomen.

Gonapophyses: (Fig. 4 & 5) in male a pair of conical processes present ventrally on the posterior region of 9th abdominal segment; in female comprising two pairs of long valvular processes arising ventrally from posterior margin of 8th abdominal segment. Outer and inner valves of the same length.

Caudal lamellae: Leaf-like, duplex and sub-nodate type in which nodi indistinct and indicated by termination point of antenodal spines,with apices ending in narrow process. Tracheation uniformly rich in median and lateral lamellae. Axial tracheal trunk prominent, a number of secondary and tertiary branches arise from this trunk.

Median lamella: (Fig. 6) 5.25 mm long and 1.50 mm wide, narrow proximally but broad in the middle. Dorsal antenodal region 1.75 mm long with 16-20 setae; Ventral antenodal region 0.75 mm long, bearing 10-13 setae. Median tracheal setae number 13-17.

Lateral lamella: (Fig. 7) 4.75 mm long, 1.50 mm wide. Dorsal antenodal region 0.85 mm, having 12-14 spines; Ventral antenodal region 1.90 mm long, with 17-23 spines. Median tracheal setae 17-20 in number.

Biology: The larvae which are found in narrow slow running streams remain attached to submerged vegetation. These streams have larval populations of *Pseudagrion rubricips* Selys, *Ceriagrion coromandelianum* (Fabricius) and *Copera marginipes* (Rambur).

Oviposition and early instars were observed in July, September and October. The March, April and September larval population mainly consists of final instar larvae. Emergence occurs twice a year; once in early summer (April) and again towards the decline of the monsoon (September, October). The larval biotopes, narrow streams, dry up in May and June. Adults were observed on wing during this period near the streams. This species is bivoltine with one monsoon brood (July to September) and one winter brood (October to March, April) at Sagar, (M.P).

Diagnosis: Kumar (1973) described the final instar larva of *Ischnura delicata* (Hagen) and *Ischnura senegalensis* (Rambur) from Dun Valley, Dehradun, India. The final instar larva of *I. aurora aurora* can easily be differentiated from that of *I. delicata* and *I. senegalensis* by the body length, head width, palpal setae and premental setae. The body length, head width, palpal setae and premental setae of final instar larva of *I. delicata* and *I. senegalensis* are 12.20 mm, 2.10 mm, 4 & 4, 4 & 4, and 13.30 mm, 2.15 mm, 5 & 5, 3_1 & ^{13} respectively. In the present study the body length, head width, palpal and premental setae of final instar larva of *I. aurora aurora* were found to be 14.42 mm, 2.88 mm, 5 & 5 and 5_1 & ^{15} respectively. The larvae of *I. senegalensis* which are also found in Sagar lake, Sagar (Suri Babu 1986) are similar to the description of Kumar (1973).

Kumar (1973) found larvae of *I. delicata* in slow running streams, weedy banks of large rivers and in temporary monsoon ponds. He found larvae of *I. senegalensis* in slow running streams, but larvae of *I. aurora aurora* were never observed in still water bodies in Sagar (M.P) However, Lieftinck *et al.* (1984) observed these larve in ponds in Taiwan.

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I thank Dr. B.K. Srivastava, Department of Zoology, Dr. H.S. Gour University, Sagar (M.P) for guidance, the late M.A. Lieftinck, Holland for identification of adult dragonflies, Dr. P.S. Corbet, University of Edinburgh, U.K. and Dr. Arun Kumar, Zoological Survey of India, Dehra Dun, for help and encouragement.

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26. OCCURRENCE OF BEEHOLE BORER *XYLEUTES LEUCONOTUS* (*DUOMITUS LEUCONOTUS*) WALKER, FAMILY COSSIDAE

Beeson (1941) has described *Xyleutes leuconotus* as a pest of ornamental *Cassia* and has given its distribution as Ceylon, India, Burma and China. However, very little is known about its status in India. Hampson (1892) noted its distribution in Simla, Sikkim, Calcutta and Ceylon.

On 6th September, 1997 Mr Naik, a BNHS member, brought a female of this moth, which was attracted to light in a residential area near Thane creek. The female laid several thousand tiny creamish eggs, but none of them hatched.

From the data it appears that the moths emerge in August/September. Mostly they are pests of *Cassia* plants and besides Mumbai (Maharashtra) they are also found in Gujarat (Ahwa Dang, Surat).

According to Barlow (1982), the distribution of *Xyleutes leuconotus* moth is northern India to Malaysia and Indonesia.

TABLE 1
COLLECTION DATA OF THE MOTH SPECIMENS PRESENT IN THE BNHS COLLECTION

Place	Date	Collector
Museum garden on *Cassia* tree Mumbai	17.viii.1946	G. Noguera
Mumbai	27.viii.1938	—
Bandra, Mumbai on *Cassia*	16.ix.1965	D.E. Reuben
Bandra, Mumbai	8.ix.1968	-do-
Ahwa Dang, Surat Gujarat.	?.viii.1962	Rev. E. M. Shull

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27. NIDIFICATION OF THREE SPECIES OF SCARABAEINAE (COLEOPTERA: SCARABAEIDAE) IN BANGALORE

The nesting and feeding behaviour of three species of dung beetles, *Heliocopris bucephalus* (Fabricius) , *Oniticellus cinctus* (Fabricius) and *Sisyphus hirtus* Weidemann, were observed at different sites in Bangalore, Karnataka. Little work has been done on this aspect of the behaviour of these species in India since the pioneering work by Hingston (1923) and Arrow (1931). We therefore give observations on nest construction, food and brood ball making and provisioning for the young in three species of dung beetles.

***Heliocopris bucephalus* (Fabricius)**

Among the largest of the Indian Scarabaeinae, these beetles, which emerge soon after the onset of the monsoon, are attracted to cow and elephant dung. They initially make shallow food burrows which they stock with less dung than their deeper, more complicated brood burrows.

Every beetle constructs an independent burrow, from within which it feeds. Each time the food is exhausted, the beetle makes a fresh burrow, which is an ongoing process. The mean diameter of the burrow entrance was 4.9 cm (4.5-5.0 cm, S.D. + 2.2), with the burrow going down to an average depth of 28 cm (15-45 cm. S.D. + 12.88). The average amount of dung in a food burrow was 186.5 (173-2000)g.

As opposed to the above, males and females cooperated in the construction of brood burrows. The male always occupied the upper portion while the female remained lower in the burrow. Initially, the tunnel was straight, to a distance of about 20 cm, after which it took an angular turn to terminate in a brood chamber. The average amount-of soil excavated for this purpose was 1014 (958-1070) g. The depth of the burrow was about 0.9 m and about 2029 g of dung was carried down the burrow.

In about 7 instances, 2 to 3 adults of *Onthophagus turbatus* were found in the dung collected by H. *bucephalus* for food or brood purposes.

***Oniticellus cinctus* (Fabricius)**

Unlike *H. bucephalus, O. cinctus* constructs a circular chamber (about 5.7 x 4.0 x 1.0 cm^3) within the dung pat, with the ground forming the floor and a crust of dung the roof of the chamber. An average of 12 (2-24) brood balls, each with a mean diameter of 1.04 (0.7-1.5) cm and a mean weight of 47.73 (27-62) mg. were present in each brood chamber

Both large and small brood balls were present in each brood chamber, the smaller ones having eggs and the larger ones larvae. Brood balls were spherical and rough, with fibres projecting from all sides and arranged in one, or occasionally two layers. The eggs were creamy white and increased in size with age. The eggs measured 2.15 (2-2.5) mm in length and 1.35 (1.0-2.0) mm in breadth. The incubation period lasted for bout 3.5 (3-4) days (Table l).

The larvae and pupae are creamy white in colour and take 17 (16-20) days and 8.5 (8- 9) days respectively, to complete their developmental periods. The adults cut an opening in the brood balls to emerge after about 26 (22-28)

TABLE 1
DIMENSIONS OF BROOD BALLS OF *ONITICELLUS CINCTUS*

	N	Min.	Max.	Ave.	S.D.
No. of brood balls/batch	15	3	24	12.27	6.46
Diameter of ball (cm)	29	0.7	1.5	1.04	0.26
Weight of brood ball (mg)	38	27	62	47.73	13.29
Dimensions of egg (cm)					
Length	10	0.2	0.25	0.21	0.024
Breadth	10	0.1	0.20	0.13	0.041

days to complete their life cycle. These beetles took marginally less time to complete their life cycle in Bangalore than in the temperate conditions under which Klemperer (1983) reported.

Sisyphus hirtus **Weidemann**

This dung roller is attracted to cow, elephant and sheep droppings. Following Fabre's (1897) classic studies not many others (Hingston, 1923; Honda, 1927 and Prasse, 1957) have worked on the genus. We give more details on the ball making, rolling and burial behaviour of this species.

Having alighted and selected a suitable area on the dung mass, the beetle cuts a piece of dung with its forelegs and clypeus and fashions it into a spheroid by compacting it against its body. The 'diameter' of the ball is 0.95 cm (0.7 - 1.1 cm, S.D. + 0.15) with a mean weight of 136 mg (50 - 190 mg, S.D. + 0.06). The ball is then rolled away by one or two beetles. If the ball is rolled by a single beetle, it uses its hind legs to push it by taking a head stand position behind the ball. When the ball is rolled by a pair, always a male and a female, then the female takes the head stand position behind the ball and pushes it while the male stands on its hind legs in front of the ball and pulls it. Sometimes the male pulls the ball so vigorously that the female is carried along with the ball. The ball is rolled along irrespective of the nature of the substrate or the presence of obstacles. Once an adult was observed pushing a ball up a slope having a gradient greater than 70°, with its last two pairs of legs. During this process, the beetle along with the ball repeatedly tumbled down the slope, but it did not give up. On another occasion a pair took 3 minutes and 5 seconds to roll the ball across a distance of 2.5 m.

In one instance, a pair of *Sisyphus* were found rolling a dung ball, which they suddenly abandoned after having rolled it for a distance of 2.1 m from the food source. The male returned to the original mass of sheep dung and examined the dung mass once again. The female joined the male and together they fashioned a fresh dung ball that was larger than the previous one, which they began to roll. After rolling for a considerable distance the beetles finally selected a burial site after having inspected many places. The female sat on the ball, guarding it, while the male made a pit by loosening the soil, using its fore tibiae and clypeus. Later the male came back and pushed the ball into the pit and disappeared under it to continue excavation. The ball gradually disappeared into the soil. After this, the female also entered the soil.

Checking these balls after a few days revealed that some had been used for feeding. In such cases only frass and the remains of the dung ball were found. Other dung balls were converted into pear shaped brood balls with an egg housed in an egg chamber situated at the top of the ball.

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28. SOME COMMENTS ON ACCURACY AND CLARITY IN RECORDING NATURAL HISTORY OBSERVATIONS

This refers to the article "Habitat and nectar resource utilisation by butterflies found in Siruvattukadu Kombei, Palni hills, Western Ghats" by Ghazala Shahabuddin (*JBNHS* 94 (2): 423-428).

I congratulate Ms. Shahabuddin for a very useful short communication. So far, the importance of lepidopteran larval food-plants and their utilisation has attracted attention. However, natural history accounts of the food resources, resource use by adult butterflies or any scientific studies on these aspects were rare. Especially in India, quality literature on these aspects is practically non-existent. Thus, any data on adult food resources is welcome and will definitely prove useful in further studies regarding movements, activity patterns and daily activity budgets of the butterflies. Ms. Shahabuddin's article is an important step in this regard.

As a butterfly watcher, I feel that certain points have unfortunately been overlooked. Some minor errors that have crept into the article might mislead an amateur butterfly watcher and these should be brought to the notice of the general reader.

Most of the errors are regarding the author's comments upon habitat preferences of particular butterfly species. The mistakes are as follows:

1. On page 427, the author writes, "It was found that Siruvattukadu Kombei harbours several species of butterflies that are rare and reportedly confined to good quality deciduous and evergreen forest, such as the Spot Swordtail, Redspot Duke, Common Banded Peacock, Water-Snow Flat, Chestnut Bob and the Common Nawab." Contrary to the author's assertion, many of these butterflies are in fact more common in scrub and disturbed or open forests. The Common Banded Peacock (I am using common names in this letter as given in Wynter-Blyth 1957), for example, is more common in scrub forests (Harish Gaonkar pers. comm., Larsen (1987). I also found the Chestnut Bob very commonly in arecanut and rubber plantations during the sampling efforts in the Western Ghats under the "Western Ghats Biodiversity Network" project. In fact, this species was much more common in disturbed areas surrounding the forests than in the undisturbed parts. Other species mentioned above are also found occasionally in various open and dry habitats. These species, therefore, cannot be considered as confined to "good quality" forests. Furthermore, all these species are either seasonally or locally common in many parts of the Western Ghats. So they are not rare in any sense; maybe some of them are rare in Siruvattukadu Kombei. However, local status can not be assigned as a regional or overall status for the species. The author says that these species are "reportedly confined", but she has not given

a supporting reference.

2. In the same paragraph on page 427, the author writes, "Endemics constitute nearly 25% of the fauna (of Siruvattukadu Kombei) discovered so far. In "endemics" the author includes butterflies that are found throughout the Indian subcontinent, surely a vast area when small insects such as butterflies are considered. The large geographical area about which the author is talking clearly reduces attractiveness of endemicity in butterflies, especially when we have very narrow endemics such as the Red-disc Bushbrown, Palni Fourring, Nilgiri Grass Yellow, Malabar Banded Swallowtail and Malabar Banded Peacock, etc. These species are either confined to a small geographical area such as the southern Western Ghats or only in Nilgiris and Palnis, etc. (Wynter-Blyth 1957, Evans 1932) or are found in a narrow range of habitats (pers. unpubl. data). The author goes on, "... and most of these were found to avoid man-modified habitats." This statement is doubtful and the observation may be faulty. It is also completely untested at the species level. I am not aware of the trends in the author's study area. Harish Gaonkar's observations (pers. comm.) and mine, and the habitats mentioned in Larsen (1987) for the species discussed by the author in this regard are contradictory. The Baron, for example, is very common in human habitations, the Southern Birdwing uses agricultural fields for breeding, the Glad-eyed Bushbrown is found in dense *Lantana* and *Eupatorium* infested forest edges, and so on. I do not, therefore, agree with the author's statements.

3. On page 423 the author mentions, "The common butterfly species are those.... and numerous Pierids such as Emigrants (Common, Mottled and African)", and on page 425 "Emigrants (all three species)". This is a serious mistake. To the best of my knowledge, there are only two species of Emigrant in India - Common and Mottled. As early as Wynter-Blyth (1957), the books mention only these two species and make clear that Common and Lemon Emigrant have been found to be the same species. The same is the case with the African and Mottled Emigrant. Larsen (1987), Haribal (1992) and Gaonkar (unpublished data) also confirm this. However, in Ms Shahabuddin's article, there are three species of Emigrant. Accordingly, the table contains an additional and outdated species of *Catopsilia.*

The following are some suggestions meant for the article in question but have wide applicability:

1. The author does not mention how and when the observations were taken. Was the observation time uniformly spread throughout the day and various months during the study period, in all the habitats and for all the species?

2. The author uses common names throughout the text, while scientific names are used in the table. There is no way to correlate common and scientific names. It would be a good idea to mention from which source the scientific names are taken. This will avoid taxonomic confusion in the text.

3. Reference to current taxonomic work should be made for scientific names. This information may be acquired from experts directly or through the Bombay Natural History Society, Zoological Survey of India, etc.

4. Common names should be used for animal groups such as mammals, birds and butterflies. Such group names have always been popular and all the species in these groups have common names, which are mentioned even in old taxonomic books (Evans 1932). Recently, there have been major changes in the common names of birds (Inskipp 1995). Fortunately, butterflies have not suffered such changes, though it may be necessary to standardise common names at least in some species, particularly where the common names overlap with other species outside Indian limits or for species whose taxonomic status has changed. However, such changes will very soon be absorbed among amateur and professional researchers. Using common names has a major

advantage in communicating to wider, less specialised readers also. Amateur butterfly watchers probably use short communications in the *Journal* more often than professionals. The use of scientific names may create a special aura around the author, but utility of the article is greatly reduced.

To conclude, I would say that the article by Ms. Shahabuddin was very useful but its value could have been greatly augmented by keeping the abovementioned points in mind.

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29. ROOSTING HABITS OF THE TAILED JAY BUTTERFLY *GRAPHIUM AGAMEMNON* (LINNAEUS) DURING THE RAINS

The Tailed jay butterfly, *Graphium agamemnon,* shows a wide range of distribution from S. India to Saurashtra, Kumaon to Assam, Ceylon and Burma (Wynter-Blyth, 1957: BUTTERFLIES OF THE INDIAN REGION). It is commonly found amidst human settlements on account of its preferred host plants, the mast tree (*Polyalthia longifolia*) and the custard apple (*Annona squamosa*). Unlike many other butterflies, the Tailed jay is active even during the hot hours of the day and may be seen fluttering restlessly over flowers. However, very little information is available on the resting locations of this butterfly during the monsoon and also the manner in which it rests.

In the monsoon of 1997, several individuals were observed roosting regularly in a densely wooded patch in a garden in Mumbai. The aggregation of butterflies in this shaded portion began as soon as it started to rain, where they continued to remain even after sunset. On drier days, however, they were found to be scattered in a wider area, even in places with scanty tree cover. However, a little shower was found to be enough to make them converge back into the densely foliated region.

Another interesting aspect was the distance of the roosting sites from the ground which was on most occasions less than 2 m. This practice not only helps them to avoid direct exposure to rain, but also keeps them away from nocturnal winged predators like bats and owls.

There is a clear preference for plants with small, dark leaves. There is also a liking for thin drooping branches on which they are generally seen perched along the upper side, close to the tip. It may be that the thinner branches transmit stronger vibrations as they are more sensitive to the movement of tree dwelling predators like a lizard or a spider. Also, by sitting along the branch they look like extensions of the branch itself. This helps them to escape predators. Moreover, if disturbed, they immediately take off and settle on another branch after fluttering suspiciously for some time.

The Tailed jay always rests on the upper side of a leaf with the head pointing upwards, irrespective of the rains. The direction of the head probably depends on the likely approach route of a predator, and the ease with which they can alight during an emergency. Moreover, the butterfly's camouflaging capability decides whether it needs to perch above or below a leaf.

The selection of a roosting site thus seems to be governed by a combination of defence strategies against nocturnal predators and instinctive behaviour to cope with harsh weather.

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30. BIOLOGICAL CONTROL OF DISEASE TRANSMITTING FRESHWATER LEECHES *HEMICLEPSIS MARGINATA MARGINATA* (MULLER) ANNELIDA: GLOSSIPHONIIDAE

Because of their habit of sucking blood from man and economically important animals, and participation in spreading protozoan and helminth diseases in the concerned hosts, sanguivorous leeches have drawn the attention of a number of workers, Davies and Everett 1975, Mandal 1984. In India, the sanguivorous leech *Hemiclepsis marginata marginata* poses a serious threat to pisciculture, froggery and turtle fisheries in so far as occurence and spread of haematozoan diseases are concerned. During the course of rearing *H. marginata* in the laboratory, destruction of eggs of this leech by a fungal strain (*Anguillospora* sp.: Moniliaceae) has been noted repeatedly and an account of the same is given below.

Of the 10 egg-bearing *H. marginata,* an unusual colouration of the body colour of five leeches and the eggs of these individuals was noted on January 15, 1990. On January 18, 1990 the colour of these eggs changed from white (original, normal colour of the eggs) to green. On January 21 and 22, 1990 all the eggs from the body of the five leeches dropped to the bottom of the container. These eggs were left undisturbed but the water of the container was regularly replaced by fresh pond water. The mother leeches gradually became sluggish and greenish. They did not even move to attack fishes to suck blood. Of the five, one died on January 27, three on January 28, and the last one died on January 29, 1990. The eggs did not hatch during the 16 days following detachment from the mother leeches and finally became denatured and decomposed. Five other leeches thrived in the same container, their eggs hatched in due course and the hatchlings were normal and healthy.

Subsequently, in other containers, a similar type of fungal infection was seen in eggs and egg-bearing leeches. Experiments were initiated to find out whether the leeches, irrespective of age and life stages, are susceptible to attack by fungal parasites, or whether the attack is confined to egg-bearing leeches. Ten individuals in the categories of three age-groups, viz. 7-10 days, 30-33 days and 90-93 days from the laboratory stock were used. All the 90-93 day-old leeches had an elongated white patch on the ventral side of the body where the eggs remain attached until they hatch and the hatchlings are detached. The individuals in the three age-groups were released separately in three museum jars, each holding one litre of pond water. Five egg-bearing, fungus infected leeches were released in each jar.

The leeches belonging to 7-10 and 30-33 day age-groups were free from fungal infection for nine days during which, however, all the fungus infected leeches died. But six individuals out of 10 belonging to the 90-93 day age-group became infected by the fungal parasites. In all cases, the initial site of infection was either the eggs or the outer covering of the cocoon. Subsequently, this spread towards the anterior sucker. The infected leeches then became inactive and were seen hanging somehow on to the wall of the jar with the help of their posterior sucker.

All the eggs became detached from the mother's body between the 4th and 6th days after the day on which the leeches became infected. All the six individuals died within a fortnight. The remaining four leeches were free from fungal attack. The hatchlings produced from their eggs were also free from any disease. They grew well and reproduced in due course of time.

Egg-bearing *H. marginata* are thus susceptible to attack by the fungal parasite *Anguillospora* sp. It appears that these fungi find the material surrounding the egg or cocoon a suitable medium for growth and multiplication. With the progress of infection, the eggs and the tissues keeping the eggs in contact with the body of the leech succumbed to the fungus. The fungi perhaps make their way into the body of the leeches through these tissues and finally kill them. Whatever be the mode of attack and nature of spreading, it is evident that these microbes are effective in reducing the numbers of leech *H. marginata* to a considerable degree. Spelling and Young (1986) have also noted mortality in older leeches *Erpobdella octoculata* due to infestation by the trematode parasites *Apatemon gracilis* in Europe. It appears that survival of many leeches is threatend by some parasites and the fungal strain *Anguillospora* sp. can be utilised in the biological control of *Hemiclepsis marginata marginata*.

We thank the Head of the Department of Zoology, Calcutta University, Calcutta for facilities provided and Prof. N. Samajpati, Department of Botany, Calcutta University for identification of the fungus.

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31. ON *CHYDORUS FAVIFORMIS* BIRGE, 1893 FROM WEST BENGAL (CRUSTACEA: CLADOCERA: CHYDORIDAE)

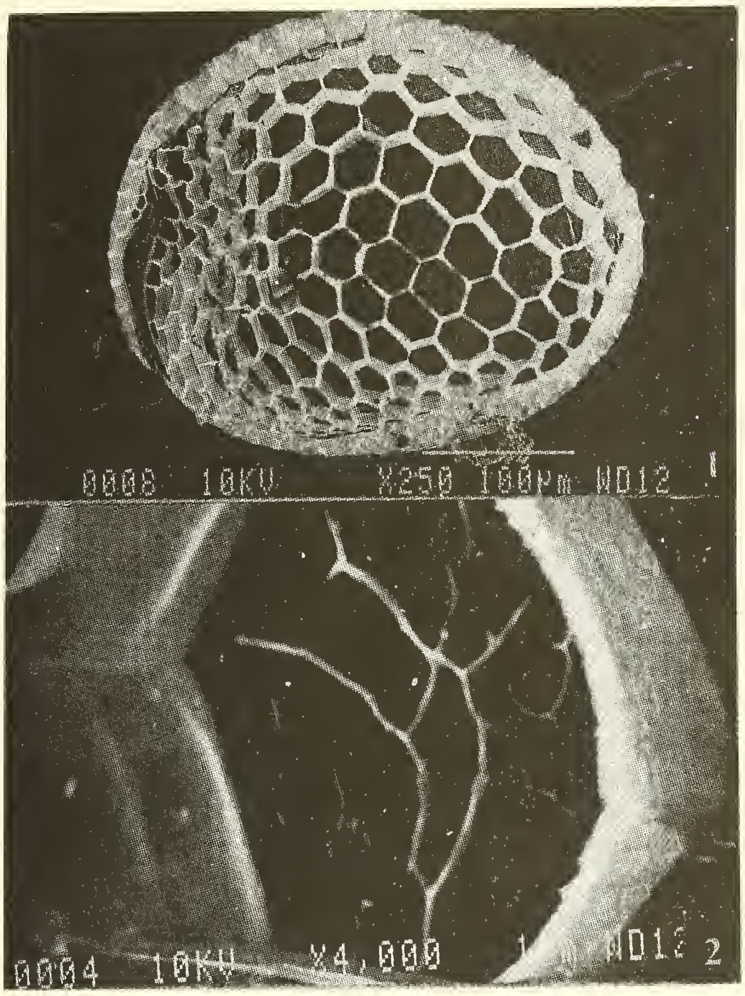
(*With six text-figures*)

During the course of a wetland survey during 1992-93, we came across several specimens of a cladoceran, *Chydorus_faviformis* Birge in the Kashipur Hoogla Jhill, Howrah District, West Bengal (22°N, 88° E). In India it was first reported from Kashmir (Khan *et al.* 1978). Michael and Sharma (1988) subsequently reported this species from Shillong. It also occurs in Argentina, U.S.A., China and Malaysia.

Family	CHYDORIDAE
Subfamily	Chydorinae
Genus	*Chydorus*

Chydorus faviformis Birge, 1893 (Figs.1-6)

Female: Body length 0.43 to 0.47 mm;



Figs. 1-2: *Chydorus faviformis* female, Scanning electron micrographs: 1. lateral view; 2. enlarged view of a hexagonal cell.

body width 0.36 to 0.39 mm. Body shape usually rounded but sometimes oval (Figs. 1, 3). Posterodorsal and posteroventral corners of valves not distinct. Valves and shield covered with deep hexagonal cells. Inner surfaces of each hexagonal cell covered with polygonal reticulations (Figs. 1, 2). Antennules not reaching apex of rostrum. Ocellus smaller than eye, situated much closer to the eye than to the apex of rostrum. Labral plate with convex anterior margin and blunt at the apex (Fig. 4). Rostrum pointed and ventrally directed. Head shield with rounded posterior margin covered with polygonal cells. Head pores typical of genus, minor pores situated slightly closer to the anterior pore than to posterior pore (Fig. 5). Postabdomen wide, with rounded apex, slightly broad with distinct pre anal and postanal corners, preanal margin greater than postanal margin. Anal spines 8-10. Groups of lateral setae of equal size present. Claw setulated on the concave surface and with two basal spines (Fig. 6).

The material collected in the present study agrees with the description of the species given by Smirnov (1974), Idris (1983) and Michael and Sharma (1988) except for a few differences. The labral plate described by Michael and Sharma (1988) has a slightly pointed apex which appears to be blunt in the present study. The body size of *C. faviformis* also shows some variation. The material collected from USA (Brooks, 1963) is 0.6 mm, from China (Siah-chih and Nan-shan, 1979) it is 0.50-0.60mm and from Malaysia (Idris, 1983) and Kashmir (Khan *et al.* 1978) it is 0.36-0.45 mm and 0.46 mm respectively. SEM studies show reticulations inside the surface of the hexagonal cells (Fig. 2). Each hexagonal cell having a highly raised wall attached throughout the body and head is characteristic of this chydorid cladoceran.

We thank the Director, ZSI, Calcutta and Dr. S.K. Tandon, Dr. N.C. Nandi and the Officer-in-charge of MBS, ZSI for facilities and encouragement.

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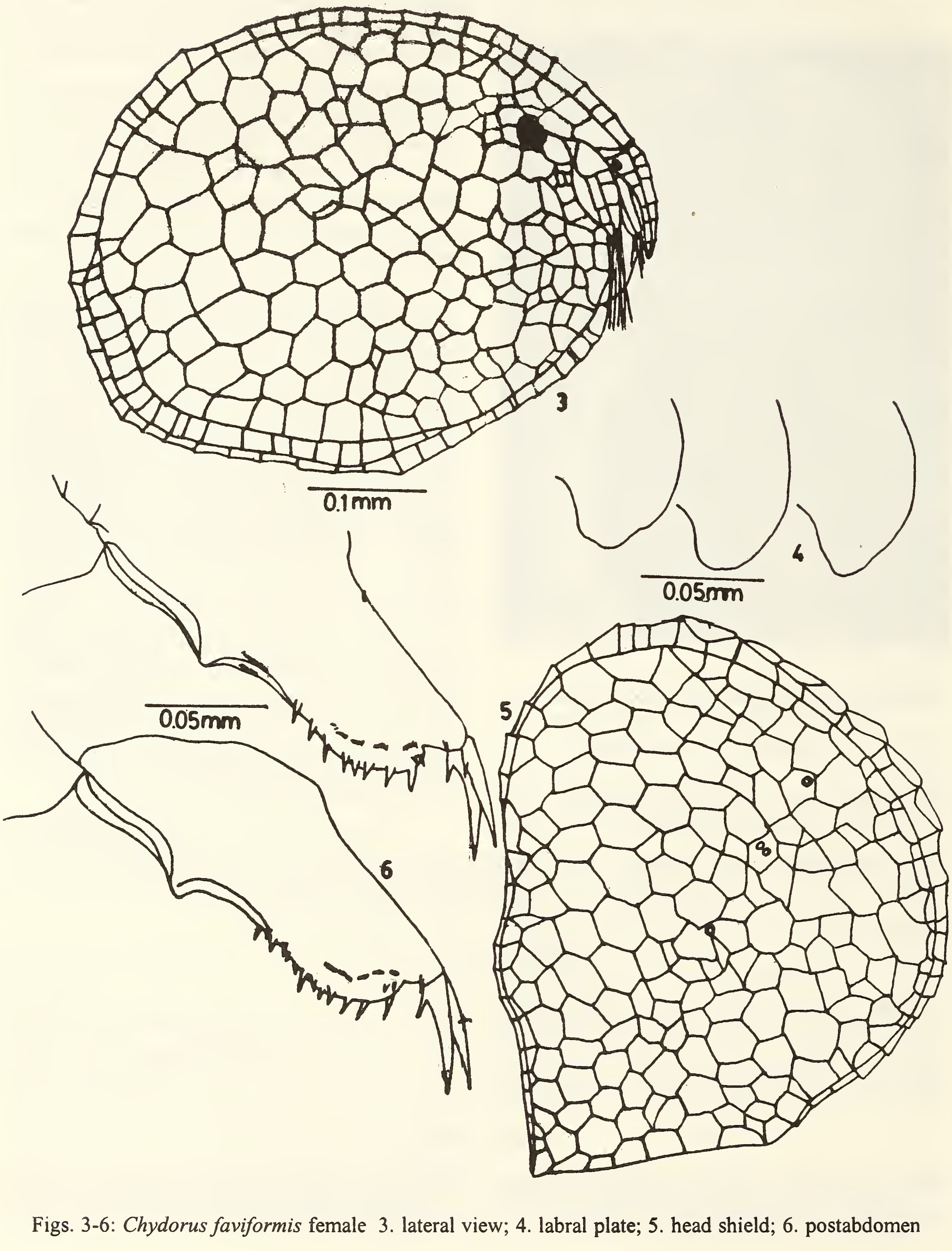
3
0.1mm
4
0.05mm
0.05mm
5
6

Figs. 3-6: *Chydorus faviformis* female 3. lateral view; 4. labral plate; 5. head shield; 6. postabdomen

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32. INCIDENCE OF ISOPOD PARASITISM ON GOBIID FISHES

During examination of a large number of Gobiid fishes from Ennore estuary, Chennai, of the species *Glossogobius giuris* (Ham.) *G. biocellatus* (Val.) and *Oligolepis acutipinnis* (Val.), the presence of isopod parasites inside the mouth was commonly observed. Among these fishes the parasites were more frequently observed in *Glossogobius giuris.* Further, *G. giuris* collected from Ashtamudi lake in Kerala were also observed to harbour these isopod parasites in the buccal region. In all these gobiids, the isopods were found on the tongue. On examination, most of the parasites were intact, some with fully developed eggs in a brood pouch. These isopods resemble *Agarna* sp. Similar observations have also been made in the buccal cavity of *Hyporhamphus limbatus* (Val.), where the isopod was observed in a depression in the lower jaw.

Cymothoid isopods are reported to occur on the external surface, buccal cavity and gills of fishes (Hutchinson 1967). Their occurrence in the mouth region has been recorded earlier by Anato *et al.* (1991) in *Boops boops* from the Gulf of Tunis. The following species of isopods, namely *Meinertia oestroides* and *M. parallela* were observed in this fish.

Earlier reports on isopod parasitism on fishes in Indian waters refer to their occurrence only in the branchial chamber. To cite a few, Tiwari (1953) reported a new species of the rare cymothoid genus *Agarna,* parasitic on the clupeoid fish *Nematalosa nasus* in the Bay of Bengal. A number of parasitised fishes examined by him revealed that each fish had only one parasite, either in the right or the left branchial chamber. Those parasites which inhabited the right branchial chamber were dextrally asymmetrical, while those which were obtained from the left branchial cavity were sinistrally asymmetrical. Except for the depression formed on the upper part of the branchial cavity, there did not appear to be any visible effect of the presence of the parasite on the host. The operculum did not show any bulging and the legs, though prehensile, seemed to play no part in the attachment of the parasite to the host. Once the parasite entered the branchial cavity of the host and grew, it could not possibly escape, as it was too big to wriggle out through the narrow gill slit. Seshagiri Rao (1974) reported the incidence of isopod parasite *Nerocila* sp. on *Ilisha melastoma,* the site of infection being the gill chamber, and he observed that this parasite is host specific. He (Rao, 1981) further analysed the incidence of Cymothoan parasites on white sardine, *Escualosa thoracata* from the east and west coasts of India. The site of infection was usually under the gill covers and rarely in the pharynx. Contrary to the observation of Tiwari (1953), Seshagiri Rao (*op. cit.*) observed that the presence of the parasite results in shrinkage of the single functional gonad which adversely affects the fecundity. The infected fishes were thin compared to the normal specimens of the same length, indicating that the parasite has an adverse effect on the growth of the host.

All these observations report isopod parasitism in the gill region of clupeoid fishes only. Their occurrence on gobiid fishes has not been reported earlier. Hence, this is the first such report. Incidentally, these isopods are always found on the tongue and they are positioned in such a way inside the host's mouth that their head faces the opening of the mouth.

ACKNOWLEDGEMENTS

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33. OCCURRENCE OF *ALONELLA NANA* (BAIRD) AND *BOSMINA LONGIROSTRIS* (O.F. MULLER,) (CRUSTACEA: CLADOCERA) IN SIKKIM LAKES

(*With two text-figures*)

While studying the zooplankton of Sikkim lakes *Alonella nana* (Baird 1834) a chydorid cladoceran and a male of *Bosmina longirostris* (O.F. Muller 1776) hitherto unrecorded in northeast India were collected from Sumdung lake and Nagi upper dam respectively. Brief descriptions of both the species are given below.

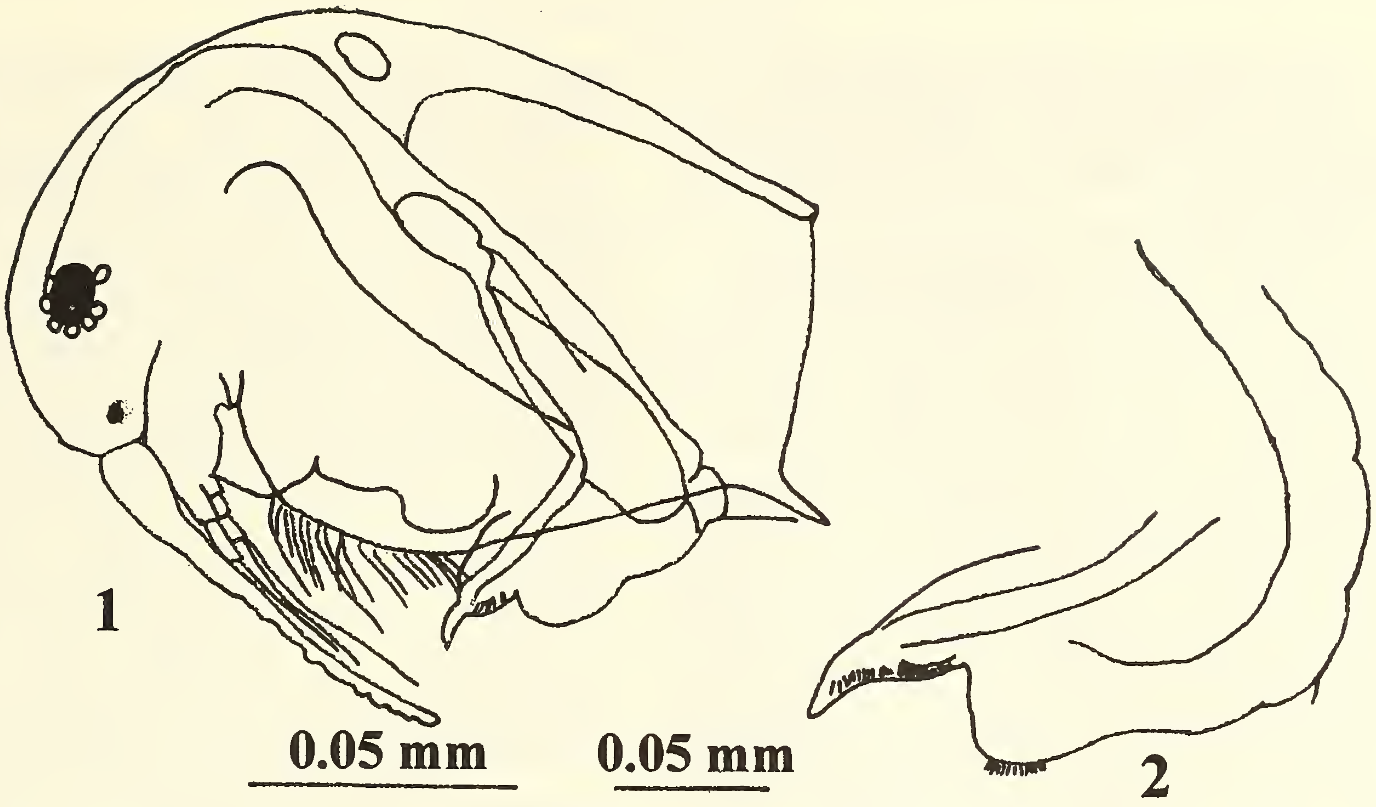
Order : Cladocera
Family : Chydoridae
Subfamily : Chydorinae

Alonella nana (Baird, 1834)

Material Examined: Seven females collected from Sumdung lake, Sikkim on 29.xi.1995, coll. B.N. Roy.

Female: Body size 0.289 mm, height 0.187 mm. Shape oval in outline. Dorsal margin smoothly convex. Posteroventral corner of valve with one or two denticles. Carapace with prominent lines directed anteroventrally and posterodorsally. Plate of labrum with pointed apex. Ocellus half the size of the eye situated nearer to the eye than to the apex of rostrum. Postabdomen with 5-6 anal spines. Claw with two basal spines.

Remarks: Brehm (1936) first recorded this species from Kashmir. After him Dr. S. Bhattacharya collected this species in Shillong (Michael and Sharma 1988). Other than India, this species was also recorded from the Holarctic region, European USSR to lake Baikal area. The



Figs. 1-2: *Bosmina longirostris,* male 1. Lateral view; 2. Postabdomen

present species was collected along with other chydorid cladoceran *Eurycercus lamellatus* from the lake mentioned above at Sikkim.

Bosmina longirostris (O.F. Muller, 1776) (Figs. 1-2)

Material Examined: Several males were collected from Nagi upper dam, Sikkim.

Male: Body size 0.249 mm; height 0.168 mm. Shape oval. Dorsal side convex, posterodorsal corner of valve angular, posteroventral corner with a spine. Head large, eye large and ocellus present. Antennules long and straight, reaching half the length of the ventral carapace. Anterior side of the ventral valve with long hairs. Hook in leg I not well developed. Postabdomen rectangular in shape, distal dorsal region with small spines. Claw with a few spines and vas deferens opening (Fig. 2).

Remarks: Even though Michael and Sharma (1988) reported that this species is cosmopolitan, males were not reported from India. In India, only females are recorded from Kashmir, Meghalaya, West Bengal and Tripura (Venkataraman and Das 1993).

I thank the Director, ZSI, Calcutta and Officer-in-Charge, Marine Biological Station, ZSI, Chennai for the facilities provided.

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34. ALLIGATOR APPLE *ANNONA GLABRA* IN THE ANDAMANS

The Alligator apple is a wild relative of the edible custard apple. This salt-tolerant SPECIES has been spotted by us recently in the Andaman Islands.

The popular and delicious fruit custard apple and its allies belonging to the genus *Annona* L., occur in over 120 species in the tropical and warmer regions of the world, of which about 5 species grow in India and 4 in the Andaman and Nicobar Islands. *A.cherimola* (cherimoya), *A.muricata* (sour sop), *A. reticulata* (bullock's heart or West Indies custard apple) and *A. squamosa* (custard apple, sweet sop and sugar apple) are well-known in India over several decades and have earned a reputation as deli-cacies. But *A. glabra* (alligator apple, pond apple, cork tree or pith wood) is perhaps a new entrant, at least to these islands. This handsome, swamp-loving tree was first recorded in India from the Vembanad backwaters of Kerala.

The alligator apple is a native of tropical America, distributed along the mangrove belts of coastal America, from Florida to Brazil and across the Atlantic in West Africa, from Senegal to Congo, West Indies, Sri Lanka and India. The occurrence of this associate mangrove in Andamans is being reported by the authors in the forthcoming issue of the Malayan Nature Journal. Spotting of this salt-tolerant plant in the Andamans is of great photogeographic as well as agronomic interest, as it is a long way from the Atlantic to Sri Lanka and southwest India where the Bay of Bengal and the Arabian Sea unite with the Indian Ocean. This probable migratory route of *A.glabra* now makes a phytogeographic bridge between Andaman Islands in the Bay of Bengal with the Atlantic ocean and the Arabian Sea across the Indian ocean. This hypothesis may be supported by its peculiar buoyant fruits, beset with a good number of salt-tolerant seeds, which are reportedly viable for 6-7 years.

The alligator apple is a small, spreading, handsome tree 3-8 m high, with greenish yellow fragrant flowers 2-4 cm across and creamy-yellow, conical, pulpy fruits upto 10 cm long, smelling like pineapple and resembling ripe mangoes. Although the fruits are not so popular here birds, squirrels and alligators do eat and relish them. The pithy wood and roots are used for making floats and corks. The appealing flavour and aroma of this pulpy fruit, as well as its choice by birds and squirrels clearly indicate its possibility as an edible fruit. The sweet-scented quality of the fruits and the salt-tolerant habit of the plant could be exploited for crop improvement programmers. As it thrives very well in swampy situations and along the backwaters, it could be developed into a promising genetic crop stock, which could be cultivated on a large scale as a salt-tolerant species in inundated fallow fields, salt marshes and brackish wetlands of India. At present, we are trying to evaluate the economic potential and nutritional value of this fruit-bearing tree. Since all the four known species of this genus from India have already found a suitable place in the field of pomology and in the fruit markets, we hope this species will turn out to be a delicious fruit crop.

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35. NOTES ON TWO LESSER KNOWN *AGLAIA* (MELIACEAE) IN ANDAMAN ISLANDS

(*With two text-figures*)

The genus *Aglaia* Lour. containing over 300 species (Airy Shaw, 1966), extends from China to Indo-Malesian, tropical Australian and Pacific regions of the world. Of these, over 23 species occur in India (Santapau & Henry, 1973) and 9 in the Andaman Nicobar Archipelago (Vasudeva Rao, 1986; Pannell, 1995). While Parkinson (1923) records 4 species of this genus and speaks of *A. argentea* Blume with some uncertainty, Vasudeva Rao (1986) lists 9 species from these Islands, including *A. argentea* Blume and *A. oligophylla* Miq. (*A. fusca* King), merely based on literature. Pannell (1995) emphasizes the occurrence of 9 species in the Andaman Nicobar Islands, out of 13 species, according to him, from India and over 105 species from the Malesian region.

While annotating the herbarium materials at PBL on Meliaceae, the authors noticed two unidentified *Aglaia* Lour., and subsequently Dr. C.M. Pannell of Oxford University confirmed them as *A. argentea* Blume and *A. oligophylla* Miq. As these species are insufficiently known from the archipelago and also poorly represented in the regional herbarium, PBL, brief botanical descriptions along with line drawings are provided to facilitate their identification and conservation.

Aglaia argentea Bl. Bijdr. 170: 1825; C.M. Pannell in *Fl. Malesiana* 12(1): 237. 1995 (Fig. 1).

Trees up to 30 m high. Leaves 10-20 x 4-6 cm. Leaflets 8-16, each 4-20 x 2-10 cm, silvery white beneath, lateral nerves 12-24 pairs, raised beneath. Flowers 2-4 x 1.5-2.5 mm. Fruits 3.0-3.5 x 2-3 cm, with 2-3 one seeded locules.

Fl. & Fr. April - June

Specimen examined: North Nicobar, Katchal, 4.v.1975 P. Chakraborty 2515 (PBL).
Distribution: Australia, Borneo, Java, Malesia, Nicobar Islands, Philippines, Solomon Island, Sumatra.
Uses: The timber is hard, heavy and durable, used for cabinets, furniture and construction.
Notes: This rare species could be easily identified by the silvery white undersurface of the leaflets.

Aglaia oligophylla Miq. Fl. Ind. Bot. Suppl. 507. 1861, *A. fusca* King *J. Asiat. Soc. Beng.* 64(2): 62. 1895; Parkinson *Fl. Andaman Islands,* 121. 1923 (Fig. 2).

Trees up to 20 m high with small buttresses. Leaves imparipinnate. Leaflets 3-11, each 4.5-22 x 2-9 cm. Inflorescence 10-20 cm long, 9-15 cm wide. Flowers 2.0 x 2.5 mm. Fruits 1-3 cm in diameter, subglobose; the pericarp brown or yellow, densely covered with pale, yellowish brown, stellate hairs on the outside. Locules 1 or 2, each contains 1 seed with a translucent white or brown aril.

Fl. & Fr. June - October.

Distribution: Andaman Islands, Borneo, Malesia, Peninsular Malaysia, Philippines, Sumatra, Thailand.
Uses: The sweet pulpy aril of the fruit is edible.
Notes: This species is similar to some *Reinwardtiodendron* sp., but differs by the features on the fruits and indumentum.

ACKNOWLEDGEMENTS

We thank Dr. C.M. Pannell, Oxford University, for identifying the specimens. Thanks are also due to Dr. P.K. Hajra, Director, Botanical Survey of India (BSI), Calcutta and Dr. P.S.N. Rao, Scientist-in-Charge, BSI, Port Blair for encouragement and facilities, and to Mr. L.N. Ray, Botanist, BSI, Port Blair for kindly sparing some of his material.

February 13, 1997

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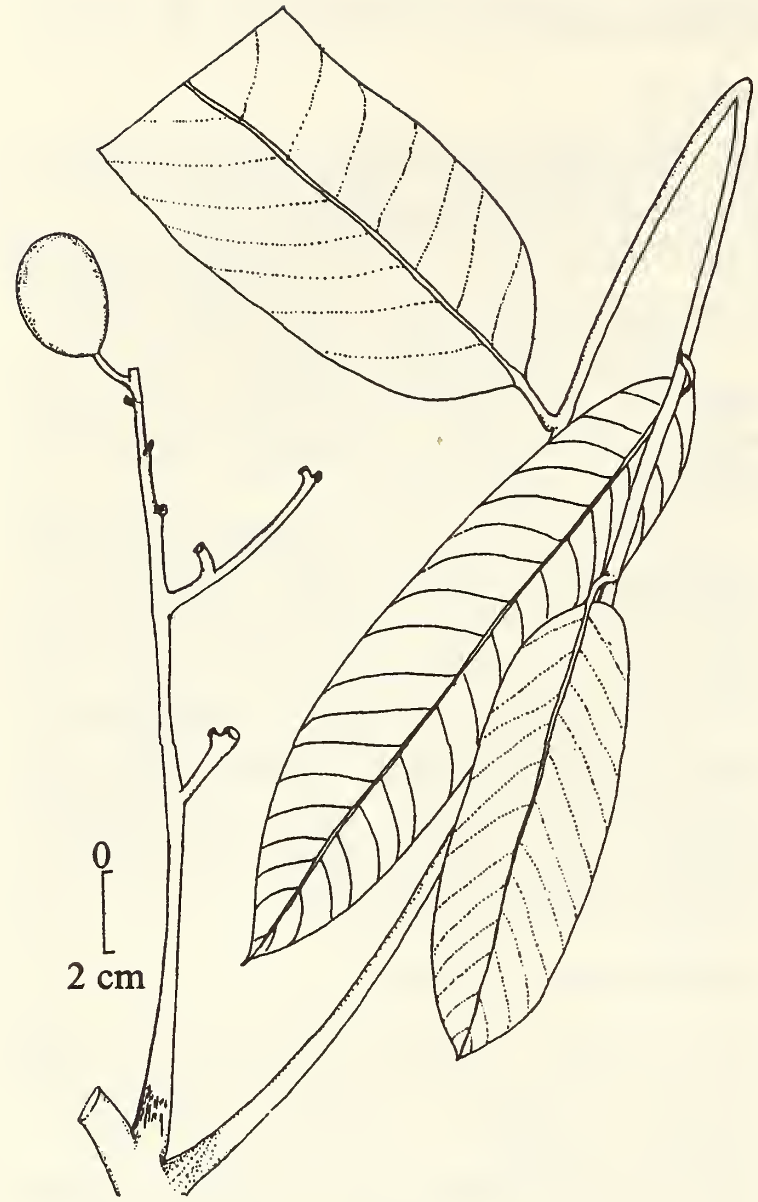

Fig. 1: *Aglaia argentea* Bl.

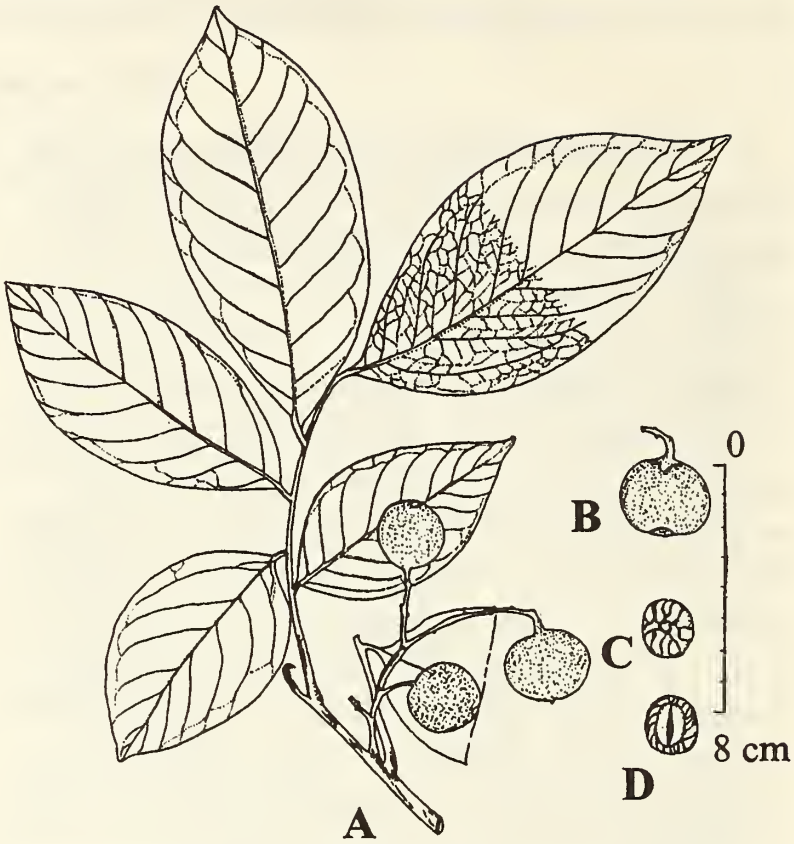

Fig. 2: *Aglaia oligophylla* Miq.
A. Habit B. Fruit C. Seed (dorsal view) D. Seed (ventral view)

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36. *CROTALARIA BURHIA* BUCH.-HAM. (FABACEAE) — A NEW RECORD FOR MAHARASHTRA

While botanizing in Wade, Jalgaon dist., Maharashtra, a curious undershrub caught my attention. On closer examination, it turned out to be *Crotalaria burhia* Buch.-Ham., a fabaceous taxon. It has not been reported from Maharashtra, and is being reported here for the first time. The taxon being a denizen of desert regions, occurs in Baluchistan, Afghanistan, Pakistan (Sind) and part of India (Cooke, 1958). In India, it is distributed criss-crossing state boundaries like Punjab, Delhi, Uttar Pradesh, Rajasthan, Gujarat and Madhya Pradesh (Bhandari, 1978). The present locality lies in the northwestern part of the Deccan Plateau of Maharashtra and is adjacent to Gujarat and Madhya Pradesh. This represents an extended distribution into Maharashtra, wherein more or less isoclimatic conditions prevail. Voucher specimens are housed in the Herbarium, P.G. Department of Botany, L.K. Dr. P.R. Ghogrey Science College, Dhule, Maharashtra.

Crotalaria burhia Buch.-Ham. (in Wall. Cat. 5386. 1831-32 (nom.nud.)) ex Benth. in Hook. Lond. Journ. 2:474. 1834 (cum descript.); Dalz. & Gibs. Bombay Fl. 54. 1861; Hook. f. Fl. Brit. India 2:66. 1876; Cooke, Fl. Pres. Bombay 1:311. 1958 (Repr. ed.); Shah, Fl. Gujarat 1:193. 1978; Bhandari, Fl. Indian Desert 1:111. 1978; Shetty & Singh, Fl. Rajasthan 1:216. 1987.

Rigid, profusely branched undershrub, branches interlacing, hoary, striate. Leaves deciduous, simple, exstipulate, subsessile, oblong, 1.4-3.5 x 0.3-0.8 cm, obtuse, rarely mucronate, silky, adpressed hairy, pale green. Flowers in terminal, 5-8 cm long racemes, pedicel short, bibracteolate; calyx hairy, 0.6-0.8 cm long, calyx-teeth lanceolate, acute; corolla yellow, streaked red, standard ovate, 0.6 x 0.5 cm, clawed, woolly, wings oblong, 0.5 x 0.2 cm, keel incurved, free towards apex, 0.7 x 0.5 cm, stamens 10, monadelphous, anthers heteromorphic; pistil unicarpellate, style hairy on one side, curved, stigma oblique; pods pilose, beaked, ovoid, seed 1-2, brown, bean shaped, compressed.

Flowers and Fruits: December-April.

Distribution: along the banks and sandy bed of river Girna at Wade and its vicinity.

Specimens examined: Wade (dist. Jalgaon): 1935, 1938.

I am grateful to Professor Dr. R.M. Pai, Ex-Head, Department of Botany, Dr. B.A. Marathwada University, Aurangabad, for going through the manuscript and for constant encouragement. I thank the Principal Mr. B.M. Patil, for facilities and Dr. S.G. Pradhan, B.S.I. (WC) Pune, for vital information.

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Cooke, T. (1958): The Flora of the Presidency of Bombay Vol. I. Botanical Survey of India, Calcutta, India. (repr.)

37. ON THE COLOURS OF THE FLOWERS OF *BAUHINIA VARIEGATA* L. (LEGUMINOSAE: CAESALPINIOIDEAE)

During a visit to the Ajodhya hills in Purulia dist. of West Bengal in the second week of February 1987, I came across a few cultivated trees of *Bauhinia variegata* L. near the Ajodhya Forest Rest House. They were flowering, with either the usual reddish purple flowers or only the pure white ones. On one of the trees with pure white flowers, I observed that in most of the flowers the uppermost petal was completely reddish purple on one side of the median line, while in others a small portion of the uppermost petal was longitudinally striped with reddish purple. I had not come across this kind of colouration in any published literature so far.

December 23, 1997 S. BANDYOPADHYAY
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On revisiting the same locality in February 1998, the interesting colouration in the uppermost petal of the flowers was found not to be present in the particular tree. Furthermore, all the petals were more reddish purple than white and a deep blotch of reddish purple colour was also present in the middle of the uppermost petal, as found in the reddish purple flowers.

38. A NEW VARIETY OF *TRICHOSANTHES TRICUSPIDATA* LOUR. (CUCURBITACEAE) FROM INDIA

Trichosanthes tricuspidata Lour., (Family Cucurbitaceae), is distributed almost throughout India (including the Andaman Islands), Bangladesh, Nepal, Bhutan, Myanmar and Sri Lanka (Chakravarty, *Rec. Bot. Surv. India* 17:44. 1959 & *Fasc. Fl. India* 11:109. 1983). The lower surface of the lamina in this species has been described by earlier taxonomists as glabrous or tomentose. In *T. tricuspidata* var. *tricuspidata* the lower surface of the lamina is glabrous, whereas in *T. tricuspidata* var. *tomentosa* (Heyne ex Clarke) Kumari, the lower surface of the lamina bears tomentose hairs. In both these taxa, the upper surface of the lamina, however, bears strigose hairs which grow sparsely or densely.

While examining a large number of specimens of *T. tricuspidata* var. *tricuspidata* and var. *tomentosa* deposited in Central National Herbarium (CAL), together with our present collections from the districts of Coochbehar, and North Dinajpur (West Bengal) we observed the following features:

i) Upper surface of the lamina is always with strigose hairs in all the specimens examined.

ii) Lower surface of the lamina is glabrous in var. *tricuspidata.*

iii) Lower surface of the lamina is tomentose in var. *tomentosa.*

iv) Lower surface of the lamina is strigose all over or only on the nerves in some of the specimens.

No other deviation has been observed in the floral morphology or other vegetative characters of these taxa.

In our opinion the presence of "strigose" hairs on the lower laminar surface densely or sparsely on the nerves is of taxonomic importance. Based on this character, we are describing here a new variety.

Trichosanthes tricuspidata Lour. var. *strigosa* Mitra & Bandyop. var. nov.

Foliis subter nervi et superficies constanter vetalus cum scabris strigosus; differt *Trichosanthes tricuspidata* Lour. var. *tricuspidata* et *T. tricuspidata* Lour. var. *tomentosa* (Heyne ex Clarke) Kumari

Holotype: West Bengal; Coochbehar (Jamalda), 22.viii.1995, coll. S. Bandyopadhyay 2904 (CAL)

Paratypus: Andhra Pradesh: Rampa district, 3.x.1920, Narayanswami 434 (CAL).

Arunachal Pradesh: 1961, Rao 24670 (CAL).

Bihar: 9.i.1903, Hains 587 (CAL); Champaran dist. 17.ix.1965, Banerjee 590 (CAL).

Karnataka: Mysore dist. Spet. 1910, Meebold 11301 (CAL); Agumbe dist. (Ghat Road), 13.x.1962, Raghaban 83179 (CAL); Hassan dist. 27.vii. Saldanha 8507 (CAL).

Kerala: 1981, Mohan 72172 (CAL); Trichur district, 5.ii.1984, Ram Murthy 72792 (CAL).

Madhya Pradesh: Bustar dist. 1.ix.1964, Aroh 5694 (CAL).

Maharashtra: Poona dist. 28.ix.1964 Venkata Reddi 98788 (CAL).

Manipur: Sengmoi (3000 ft.), 20.v.1882, Watt 7162 (CAL); on the way to Keithemabi (3000 ft.), 4.ii.1881 Watt 5831 (CAL); Naga hills (5000 ft), 7.vii.1948, Mukherjee 3169 (CAL); Nungba,?. .xi.1907, Meebold 5875 (CAL).

Meghalaya: Khasia & Jaintia hills, 13.x.1910, Hoopa 34686 (CAL); Khasia hills (5500 ft.), 29.viii.1885, Clarke 40292 (CAL); Khasia hills, Griffith 2539 (CAL); Shillong, 3.vi.1963, Deka 3314 (CAL).

NEFA: 1961, Deb 26051 (CAL); 19.x.1959, Rao 20045 (CAL); 22.viii.1958, Panigrahi 14568. (CAL).

Orissa: Mayurbhanj district, 23.iii.79, Biswas, (CAL); 1983, Safui 13500 (CAL).

Tamil Nadu: Tinnevelly (200 m), 23.iii.1958, Subramanyam 5634 (CAL).

West Bengal: Birbhum, 28 Aug. 1966, Basak 594 (CAL); Darjeeling (6500 ft), 5.vii.1956, Chatterjee 24 (CAL); Darjeeling (4000 ft) 28.vii.1870, Clarke 12243 (CAL); Howrah 26.viii.1964, Bennet 969 (CAL); Malda, 1966, Dutta 350 (CAL).

Purulia, 20.iv.1968, Malik 546 (CAL); West Dinajpur (Chopra), 22.viii.1995, Mitra 2449 (CAL).

Bangladesh: Jessore, 1874, Clarke 21811 (CAL).

Myanmar: Upper Burma, ?.vii.1888, Khan 130 (CAL).

Nepal: 1951, Williams 5202 (CAL).

Trichosanthes tricuspidata Lour. var. *strigosa* var. nov. differs from the related taxa *T. tricuspidata* Lour. var. *tricuspidata* and *T. tricuspidata* Lour. var. *tomentosa* (Heyne ex Clarke) Kumari by the presence of strigose hairs on the lower laminar surface all over, densely or only on the nerve sparsely.

Distribution: Andhra Pradesh, Arunachal Pradesh, Bihar, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, NEFA, Orissa, Tamil Nadu & West Bengal, India; Bangladesh, Myanmar, Nepal.

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We are indebted to Dr. G.G. Maiti of Kalyani University for the Latin diagnosis and also to Dr. Subir Bandyopadhyay for his help and suggestions.

December 23, 1997

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39. A NEW RECORD OF *THRIXSPERMUM MERGUENSE* (HOOK.F.) KUNTZE (ORCHIDACEAE) FROM NICOBAR ISLANDS

The genus *Thrixspermum* Lour. with an estimated number of species between 100 to 150 (Seidenfaden, 1992) in the world is represented by only eight species in India (Karthikeyan *et al*, 1989; Sathish Kumar and Manilal, 1994; Seidenfaden, 1992) after *T. album* is considered conspecific with *T. trichoglottis* by Holttum and with the relationship of this taxon to a series of taxa, especially the classical *T. hystrix,* remaining unresolved.

T. merquense (Hook.f.) Kuntze, hitherto known to be distributed from Myanmar (Tenasserim) eastwards to Taiwan and the Philippines, as well as Sumatra, Java and Krakatau, is being reported here from Nicobar Is. after the identification of the specimen is confirmed on the basis of the illustrations and literature (Seidenfaden, 1992). With this new report, the total number of species so far known to occur in Andaman and Nicobar Is. is three, the other two being *T. trichoglottis* and *T. amplexicaule.* A brief description of the orchid species is provided below to facilitate easy collection and identification in the field.

Thrixspermum merguense (Hook.f.) Kuntze, Rev. Gen 2: 682, 1891.

Sarcochilus merguense Hook.f. t Fl. Brit. India 6: 401 1890.

Small epiphytic plants; stem up to 1 cm long, clothed with the imbricating bases of the distichous leaves. Roots wiry. Leaves up to 3.5 x 1.0 cm, retuse. Inflorescence almost as long as leaves; rachis 1 cm long. Bracts closely arranged, triangular, acute, up to 1 mm long. Dorsal sepal up to 2.5 mm long. Petals slightly smaller. Lip with tufts of hairs at the distal end, and one tuft centrally located; the side lobes broadly triangular. Column up to 1 mm long, narrowing towards the base. Fruit not seen.

Specimens examined: Andaman-Nicobar Islands: Great Nicobar island, 41 km from Campbell Bay on north-south road along the Galathea river, 7.iv.1995, Coll. V. Maina and B. K. Sinha 20599 (PBL).

Distribution: India (Gt. Nicobar Island), Myanmar, Taiwan, Philippines, Sumatra, Java and Malaya.

Conservation: As the species is very rare in India and restricted to Gt. Nicobar, steps should be taken for its conservation in view of various developmental activities taking place in the island territory of late.

We are thankful to Dr. P. K. Hajra, Director, Botanical Survey of India, Calcutta for encouragement.

January 25, 1997

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ANTLER CYCLES AND BREEDING SEASONALITY OF THE CHITAL (*AXIS AXIS* ERXLEBEN) IN SOUTHERN INDIA[1]

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(*With six text-figures*)

Key words: Antler development, fawning, circannual rhythms, age-specific reproduction, tropical dry evergreen forest, axis deer, *Axis axis.*

Annual cycles of antler renewal and casting, and births in a free-ranging, high-density population of chital or axis deer were studied for 2.5 years in Guindy National Park in southern India. In all the three age-classes (yearling, juvenile, and adult males), seasonality was pronounced and birth seasonality was evident. Occurrence of most births (49%) between December and March, at the onset of the dry season, probably enabled the energetically expensive late-lactation period of females to coincide with the first flush in food availability after the rains. Only adult males attained peak hard antler during the months when most conceptions occurred; the monthly percentage in hard antler. was significantly correlated with fawning 8-9 months later. Time-lag correlations and patterns of antler development showed that the peak in hard antler of juvenile and yearling males occurred 2.5 and 5 months later than in the adult males. Such staggered rutting cycles may reduce inter-male conflict and increase the chances of subordinate age-classes achieving copulation.

INTRODUCTION

Breeding cycles of deer are known to be closely linked to annual environmental rhythms in the temperate regions. In the tropics, where environmental rhythms are relatively diffuse and unpredictable, breeding is often considered to be markedly less seasonal or aseasonal (Lincoln 1992 a,b). There is evidence, however, that many mammal species in the tropics and equatorial regions also show distinct seasonality which is influenced by factors such as photoperiod, rainfall, food availability, and genetics (Bronson 1989).

Deer offer a unique opportunity to study breeding seasonality due to their habit of sporting antlers. These bony outgrowths of the cranial frontal bones occur in 36 of the 40 extant deer species, and are grown and cast at roughly annual intervals in consonance with seasonal sexual cycles (Goss 1983, Lincoln 1985, 1992b). In all species that possess antlers, excluding the reindeer (*Rangifer tarandus*), only males carry antlers (Lincoln 1992b). Yearling males in most species produce their first set of antlers on reaching puberty, and successive sets of antlers in ensuing years increase in size and complexity parallel to the increase in body size. Rutting males can be distinguished easily by the exposed, bony, hard antlers they carry, in addition to characteristic sexual behaviour (deVos *et al.* 1967, Goss 1983, Lincoln 1992b, Mishra and Wemmer 1987, Schaller 1967). In addition to antler size and body condition, the reproductive success of males in polygynous species also changes according to the age of the individual

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(Clutton-Brock 1982, 1987). Prime-aged adult males can be expected to rut during the annual peak in female oestrus. If male-male competition for females is high, younger or subordinate males may then be forced to rut at different times of the year when adults are in velvet or exhausted after their rutting activities (Dunbar *et al.* 1990, Hirotani 1994). Monitoring monthly changes in the proportion of males of different age classes in hard antler, along with fawning peaks, can be used to examine breeding seasonality and age-related reproductive strategies of deer.

The chital or axis deer, *Axis axis* Erxleben, is an endemic cervid of south Asia occurring between *c.* 8°N and 30°N in India, Sri Lanka, Nepal, and Bangladesh (Schaller 1967). This, coupled with the fact that it is common and widespread within its range, makes it a suitable representative for research on the ecology of tropical cervids, which have been poorly studied as compared to temperate zone cervids (Lincoln 1985, 1992a,b, Loudon and Brinklow 1992). There have been several studies on the natural history and ecology of chital in India and Sri Lanka where it is native (Barrette 1985, 1987, Berwick 1974, Eisenberg and Lockhart 1972, Johnsingh 1983, Krishnan 1972, Mishra 1982, Mishra and Wemmer 1987, Miura 1981, Schaller 1967, Sharatchandra and Gadgil 1975, Tak and Lamba 1984), and in other countries where it was introduced (Ables 1977, Graf and Nichols 1966). Quantitative information on antler cycles and breeding seasonality is, however, available in only a few studies (Fuchs 1977, Graf and Nichols 1966, Johnsingh 1983, Mishra and Wemmer 1987, Schaller 1967, Sharatchandra and Gadgil 1975). Among these, Fuchs (1977) also examined antler cycles within different age classes of males for a single year.

Reports from studies of captive herds of seasonal synchrony in annual antler and birth cycles have been conflicting (Bubenik *et al.* 1992, Loudon and Curlewis 1988). In the wild, however, studies have generally documented some seasonality (Johnsingh 1983, Mishra and Wemmer 1987, Schaller 1967, Sharatchandra and Gadgil 1975). The pulse of seasonality is seen to be weak, at least some males being in hard antler throughout the year (Fuchs 1977, Mishra and Wemmer 1987, Schaller 1967). It is not clear, however, whether the males rutting outside the peak rut are adults or younger males whose rut is staggered relative to adults — an important aspect of age-related reproductive strategies. This paper presents a comparative account of antler development in different age classes of males, and birth seasonality over 2.5 years in a free-ranging, high density population of chital in southern India. The existence of age-related differences in antler cycles of males is examined in relation to female breeding seasonality and births and compared with those from previous studies on chital and other cervids.

STUDY AREA

Guindy National Park (GNP) is a 2.7 km^2 park located in the southwest corner of Chennai (Madras) city (13°N, 80°E) in south India. The vegetation, appearing as patches of scrub jungle, thickets, and wooded areas, corresponds to the Tropical Dry Evergreen Forest of Champion and Seth (1968), reclassified as the *Albizia amara* Boiv. community (Puri *et al.* 1989). A detailed description of the park is available elsewhere (Raman *et al.* 1996). The mean annual rainfall is 1215 mm, most of which falls during the northeast monsoon in October-November, though the park receives rain during the pre-monsoon (April-May) and the southwest monsoon (June-September) as well (Fig. 1). The park is home to a small native population of about 50 blackbuck (*Antilope cervicapra* L.) and a high-density population of about 550 chital (212.3 chital/km^2 during 1991-92, line transect estimate in Raman *et al.* 1996).

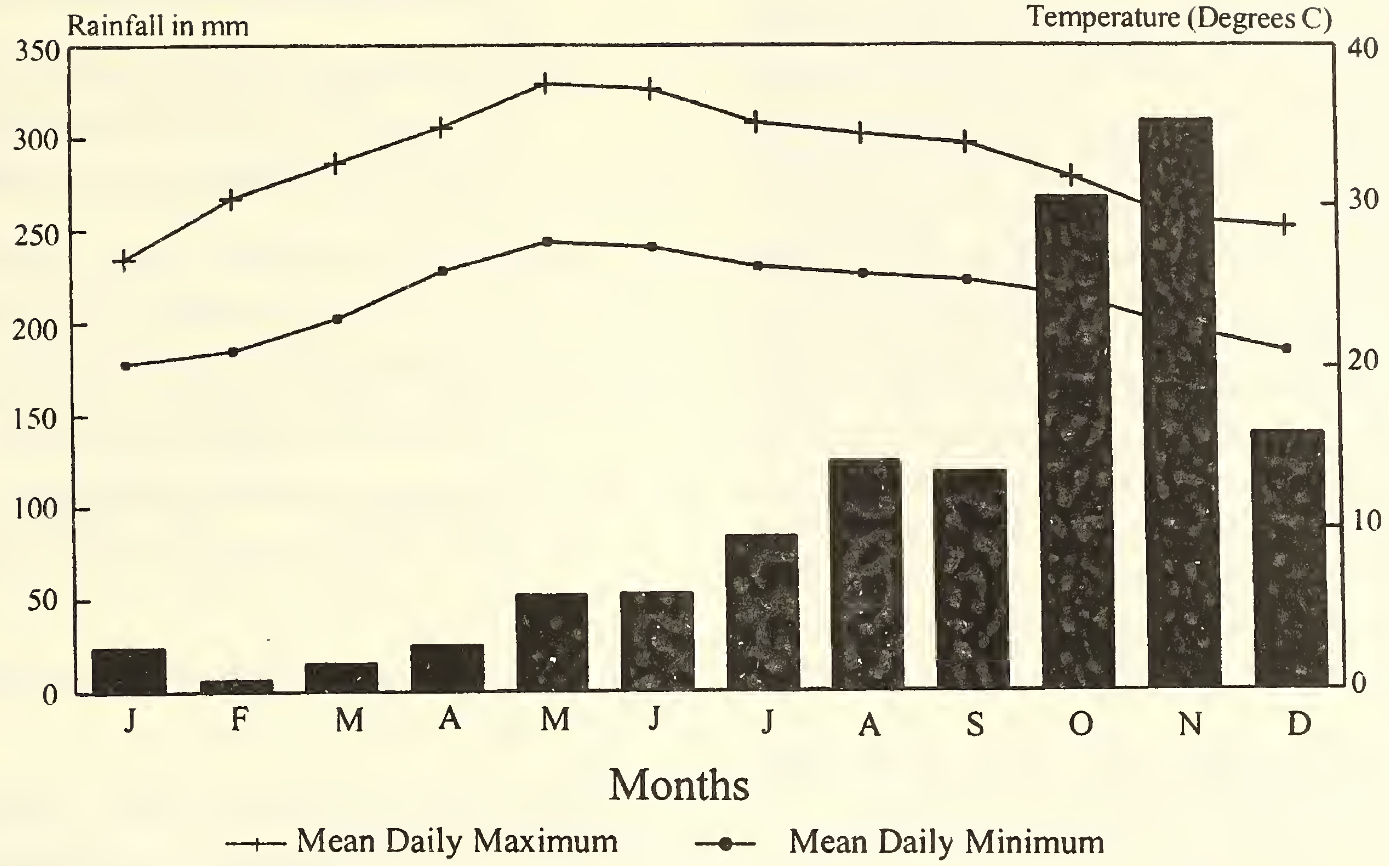

Fig. 1: Rainfall (vertical bars) mean monthly maximum and minimum temperatures for GNP. Data averages for 1931-1960 from the Climatological Table for Chennai (Minambakkam). Rainfall and temperature regimes were similar during the study period 1991-93. (see Raman *et al.* 1996).

METHODS

Six months (July-December 1990) of preliminary observations were made on over 500 free-ranging individuals in GNP, concurrent to observations of captive chital in the adjacent Children's Park zoo. Based on these observations, the age-sex and antler-stage classification of chital by Schaller (1967) was substantially refined (see below). A total of 12,866 individual chital were classified into different age-sex and antler categories between January 1991 and May 1993 (sampling with replacement). An average of 444 (range 121-920) chital were classified each month, which comprised, on an average, of 232 adult females (76-488), 35 yearling females (2-67), 35 fawns (2-80), 82 adult males (29-170), 31 juvenile males (6-73), and 32 yearling males (2-74). Around eight field visits were made each month, with 3-5 trips each in the morning (0600 to 1000 h) and evening (1600 to 1900 h), the times of day when animals were most active. Observations were made along established transects, forest trails, and roads using a pair of 7 x 50 binoculars. Accurate classification of individuals was possible because the chital in GNP are generally not very shy of humans and can be approached easily to within 30-50 m, often to less than 20 m. Animals more than 100 m away, and those not seen clearly, were not classified. Bellows (rutting call given by adult males usually consisting of 3-5 loud notes) heard in the field were also recorded.

Age-sex and antler classification

Females could be classified only as adult or yearling females in the field (Schaller 1967). Fawns were classified as small fawns (<2 months) and big fawns (>2 months), based on their height in relation to that of adult females whom they almost invariably accompanied. Fawns could not be sexed in the field. Males were classified into 16 categories (see below) representing different stages of maturity and antler condition within three age groups — yearlings, juveniles and adults. Having these broad groups facilitated distinguishing the age class of individual males irrespective of antler condition, by looking at antler pedicel height (which declines with age), pedicel width, and head and body sizes (which increase with age). The detailed classification of antler development stages within each age class allows the monitoring of seasonal changes at a finer level and identifying the rutting period clearly.

(A) Yearling Males or Spikers, age 10 months - 2 yr) were classified as follows:

(i) Button Male: Only a stub-like developing pedicel (*c.* 2 cm), completely covered by hair, is visible on the head.

(ii) Velvet: A blunt, spike-like growing antler covered in fawn-coloured 'velvet' and mounted on a tall (*c.* 4-5 cm) pedicel.

(iii) Dry Velvet: A pointed spike-like antler, 10-12 cm long, with a thin grey covering of velvet.

(iv) Hard Spiker: Hard bony antler with no trace of velvet. This includes an intermediate stage, namely, yearlings with the velvet peeling off before the hard antler stage. Such individuals are rarely seen, presumably because this process occurs in just a few days.

(B) Juvenile Males (age 2-3 yr) were classified as follows:

(i) Cast Yearling: Only the tall pedicel of the yearling is present, with signs of the wound at the burr where the antler was cast.

(ii) Growing Velvet: Bulbous-tipped antler usually with a small brow tine.

(iii) Mature Velvet: Antler reaches nearly full length of 20-30 cm and has a rounded (*not* bulbous) tip and a fawn colour.

(iv) Dry Velvet: Antler is mature, pointed, and covered by a thin but entire covering of dark, greyish velvet.

(v) Peeling: Strips of velvet usually hang loose from the antler and portions of the bone are visible underneath.

(vi) Hard: Hard bony antler with no trace of velvet left.

(C) Adult Males (age > 3 yr) — Six adult male classes were considered:

Cast Adult, Growing Velvet, Mature Velvet, Dry Velvet, Peeling, and Hard antler adults were distinguished as in the case of Juvenile Males. Antler beam, pedicel, and body size were larger than for Juvenile Males and enabled unambiguous classification in the vast majority of cases.

Analyses

The percentage of males within each age class in the different stages of antler condition was computed for each month between March 1991 and May 1993. Initially (January-March 1991), adult and juvenile males were not distinguished, hence the data were not included in the age-specific analyses.

For each month, the number of small fawns (age < 2 months) was expressed per 100 adult females to examine seasonality in births. The number of bellows heard during 0600-0900 h and 1600-1900 h was divided by the number of hours spent in the field in those time blocks to get an index of bellowing rate (bellows/hour).

Sinusoidal curves were chosen to fit the data on the annual antler cycles (Batschelet 1981).

The curves were of the form:

$$y = A \cos \frac{\pi}{6} (t - t_{max}) + \overline{H}$$

where: y — percentage of males (of a given age class) in hard antler.

t — month number (ranging from January = 1 to December = 12).

A — amplitude (a measure of the extent or magnitude of the seasonality pulse).

t_{max} — the month which is the peak in the annual cycle,

$\overline{H}$ — annual mean of the monthly percentage of males (of that age class) in hard antler (a constant estimated from the data).

The parameters of the curve have biological relevance (Batschelet 1981: 159). The parameter t_{max} estimates the month (Jan. = 1 to Dec. = 12) when the peak in antler cycles is reached. Similarly, the estimated value of the peak percentage of males in hard antler during the annual cycle is given by $A + \overline{H}$ (when $t = t_{max}$, $y = A \cos (0) + \overline{H} = A + \overline{H}$). Initial estimates of A and t_{max} were derived iteratively and these were used to perform non-linear regression using SPSS/PC + software (Norušis 1990).

TABLE 1

BREEDING SEASONALITY OF ALL CHITAL MALES CONSIDERED TOGETHER AND AS SEPARATE AGE CLASSES*

Male Age Class	Amplitude (A)	Peak month (t_{max})	Mean monthly % in hard antler ($\overline{H}$)	R^2 %	N
All Ages	18.56	7.10	55.4	84.9	26
Yearling	18.35	11.35	45.3	39.7	26
Juvenile	34.24	8.67	60.4	79.6	26
Adult	28.31	6.25	56.9	89.0	26

*Parameter estimates from non-linear sinusoidal curve fitting data in Figure 2. For explanation of parameters see text (Analyses).

To examine temporal differences between antler cycles of different age classes of males, time-lag correlations were used as explained below. This was also used to correlate male peaks in hard antler with births 8-9 months later (this corresponds to the gestation period in chital: English 1992, Rao 1984; see Discussion). In these analyses, a lag of one unit corresponded to one month, and a range of 0-12 lag units was employed. Pearson's product-moment correlation coefficients were computed in each case. The lag at which the maximum significant positive correlation existed between the antler cycles of two age classes of males represented the number of months separating their peaks in hard antler. Similarly, a significant positive correlation between the percentage of males of a given age class in hard antler in a given month and the number of small fawns observed 8-9 months later indicated whether the peaks in hard antler coincided with incidents of mating and conception.

RESULTS

Age-specific antler cycles

Males in hard antlers were seen throughout the year, with 50% (40%) or more males being in hard antler during 8 (10) out of the 12 months of the year (Fig. 2a). When considered by age-class, however, more distinctly seasonal patterns are evident (Fig. 2b-d). The amplitude or extent of the seasonality pulse of all males combined in the analysis was lower ($A = 18.56$), compared to the seasonality of adult or juvenile males coming into hard antler ($A = 28.31$ and 34.24, respectively, Table 1). The extent of seasonality appeared to be low for yearling males ($A = 18.35$), but the curve fit was poor in this case ($R^2 = 0.40$) and the data also suggests a more distinct seasonality than for all males considered together (Fig. 2b *vs* 2a).

A majority (73-91%) of the adult males came into rut and hard antler between March

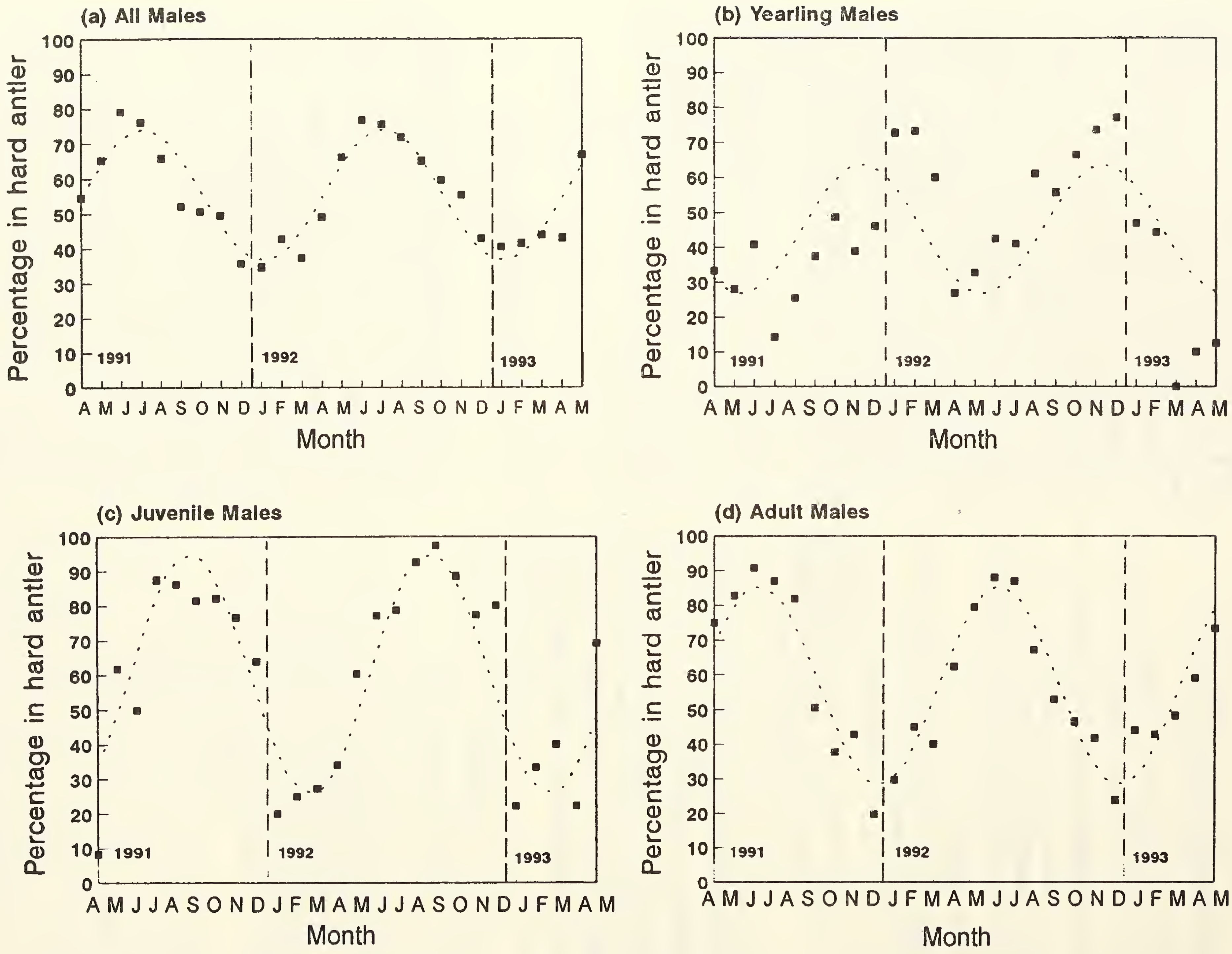

Fig. 2: Seasonality of antler cycles modelled as sinusoidal curves as monthly percentage of (a) All Males, (b) Yearling Males, (c) Juvenile Males, and (d) Adult Males, in hard antler.

and July, with the peak in hard antler being in July (t_{max} = 6.3, Fig. 2d). Most of their rutting activity appeared concentrated between April and July, the period when the number of bellows per hour was highest. Thus, available data for April-December 1991 showed that the percentage of adult males in hard antler during a given month was positively correlated with the number of bellows per hour that month ($r = 0.85$, $df = 7$, 2-tailed $P = 0.004$).

Juvenile males, in contrast to adult males, came into hard antler much later, reaching a peak around late September (t_{max} = 8.7, Fig. 2c) when most adult males began to cast antlers (August-October). Juveniles cast antlers mostly during November-January as was evident from the fall in the hard antler curves for the two age classes (see Fig. 2, and Antler development). Yearling males (spikers) were out of phase with both adult and juvenile males. Thus, the percentage of yearling males in hard antler peaked around December (January in 1991 and December in 1992, t_{max} = 11.3, Fig. 2b). Thus adult and juvenile male peaks were separated by about 2.4 months, while juvenile and yearling male peaks were separated by 2.7 months. This was confirmed by time-lag correlation analyses. Comparisons were made between the antler cycles (monthly percentage in hard antler) of juveniles and adults and between juveniles and yearlings. In each case, they were each out of phase by about 2-3 months as shown by the higher and significant positive correlations at the corresponding lag (Fig. 3). Thus, yearling and adult males were out of phase by about 5.1 months.

These distinctly age-specific seasonal patterns were evident in 1991 and 1992, and even in the data for the first five months of 1993. Only

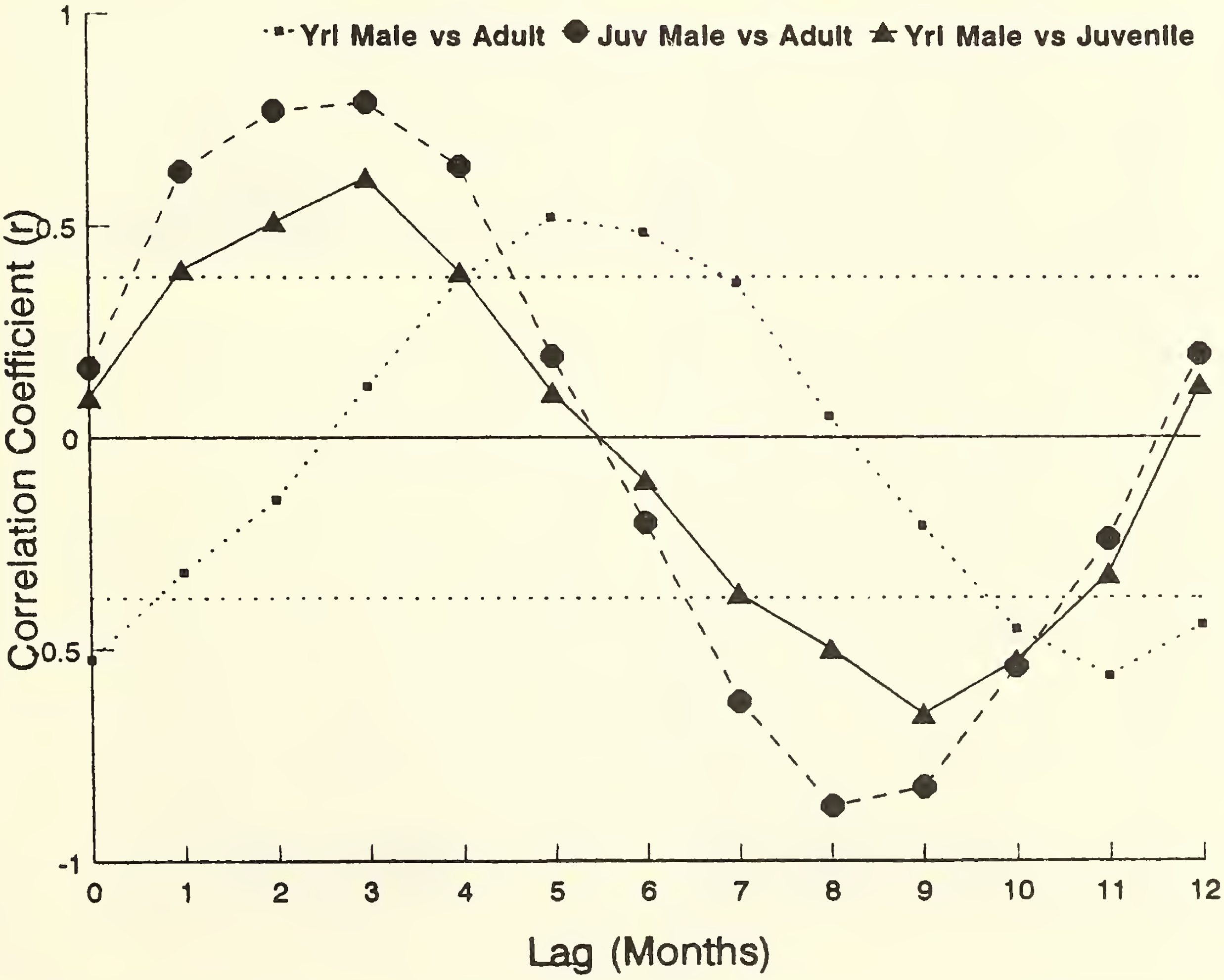

Fig. 3: Time-lag correlations between different age classes of male chital in the monthly percentage in hard antler. Pearson product-moment correlation values falling outside the range encompassed by the horizontal dotted lines are significant (2-tailed $P < 0.05$).

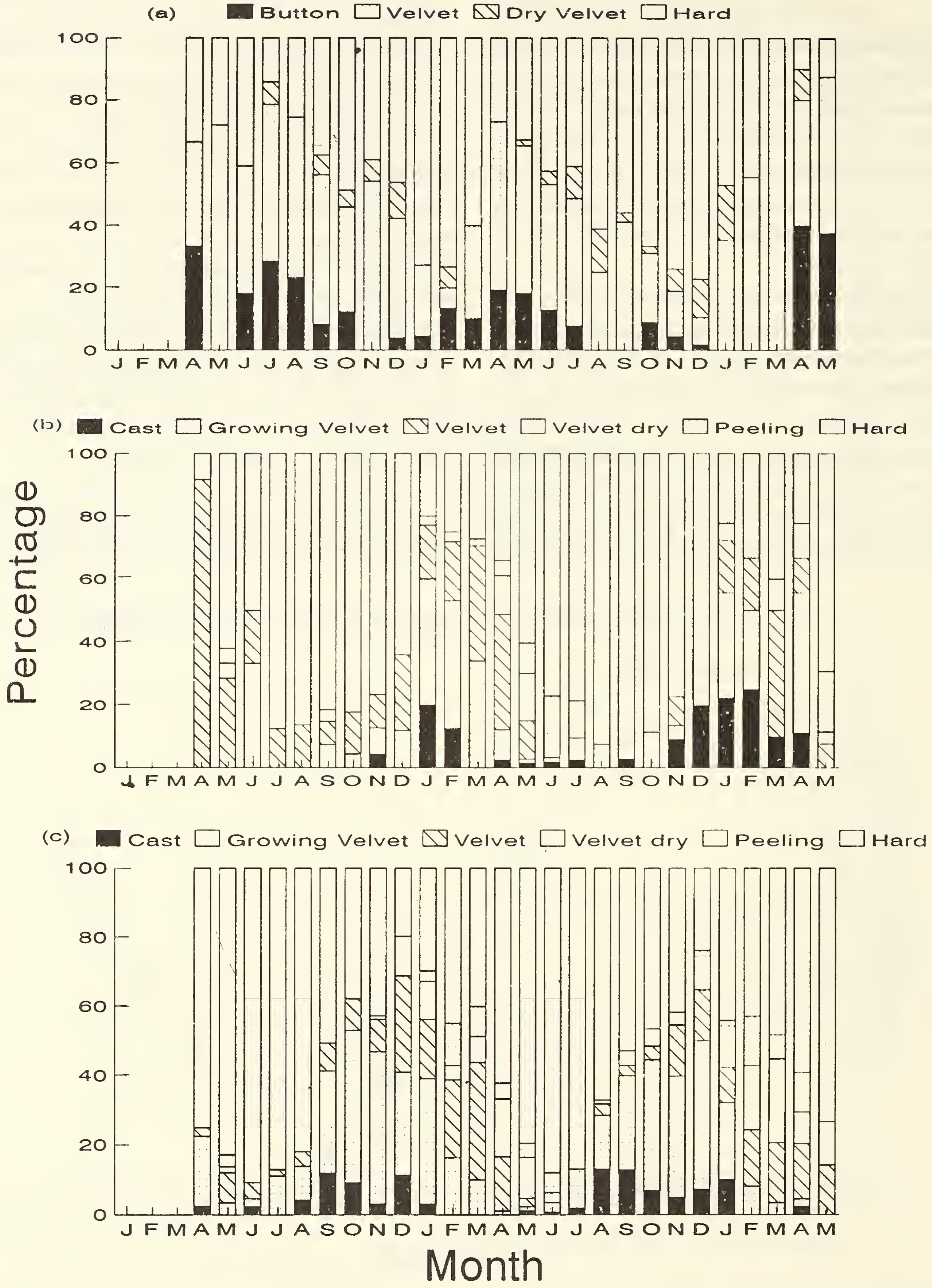

Fig. 4: Antler development in (a) Yearling Males, (b) Juvenile Males, and (c) Adult Males during 1991-93 as monthly percentage of individuals in different stages of antler development.

if males of all age classes are pooled, is an overall flatter curve obtained, indicating milder seasonality. It is clear, however, that even the pulse of age-specific seasonality is not absolute, as about 20% of the adult males were in hard antler even during the lowest month (December, but see Discussion).

Antler development according to age class

Consideration of different stages of antler development reinforces the above patterns. Yearling males in the 'Button Male' stage were observed as early as November-December, when they were 10-12 months old (assuming that they were born during the birth peak in January-February). A few button males were seen till about May-June the following year (Fig. 4a). During the following months, yearling males were mostly in velvet and dry velvet till about August-October, when many of them started turning from dry velvet into hard spikers over the winter. Most yearlings cast their antlers the following January-February, and the approximately 2-year old males now entered the juvenile age class.

The juvenile males were in growing and mature velvet till April-May; they cleaned their antlers of velvet, achieving their peak in hard antler between June and September (Fig. 4b). Interestingly, these were the months when most adult males had just cast their antlers (Fig. 4c). A majority of juveniles cast their hard antlers after December and entered the adult male age category as 3-year olds. These individuals then came into hard antler earlier than in the previous year, more or less in phase with the other adult males in the population. Between September and December, most adult males had growing antlers. By the following April, 60-75% of the adults had passed through the dry velvet and peeling phases to attain hard antlers and begin to rut.

Fawning seasonality

Births of fawns also clearly indicated seasonality (Fig. 5). The proportion of small fawns per 100 females peaked in February in 1992 and 1993. In 1991, a peak in births is also apparent in April, the reason for which is unknown. During 1991-92, most small fawns (49.2%) were noticed between December and March. Fawns two weeks to one month old could be seen moving with females. Based on the sizes of fawns in the field, my observations indicated that most births in GNP occurred between mid-December and mid-February. Very few births occurred between July and November. Only adult males showed a significant correlation between rutting (monthly percentage in hard antler) and fawning after a lag of 8-9 months, corresponding to the gestation period (Fig. 6).

DISCUSSION

The antler cycle of chital in Guindy National Park appears, at first glance, to indicate a very diffuse seasonality as at least 50% of the males are in hard antler for 8 out of 12 months of the year. This has prompted observers in the past to conclude that chital breed aseasonally, even though each male may have its own yearly seasonal cycle (Inverarity 1895, Krishnan 1972, Lincoln 1992a,b, Loudon and Curlewis 1988). The present study shows, however, that the antler cycle of individual age classes of males reveals distinct seasonal patterns. Most of the adult males (73-91%) are in hard antler between March and July, with a peak in May-June. In contrast, juvenile and yearling males peak about 2.5 and 5 months later.

Such staggered antler cycles of different age classes of deer have been reported even in temperate cervids exhibiting greater seasonality of breeding such as the Sika deer *Cervus nippon* (Miura 1984a) and reindeer (Leader-Williams 1988). In red deer *Cervus elaphus,* dominant males tend to cast antlers (and come into hard

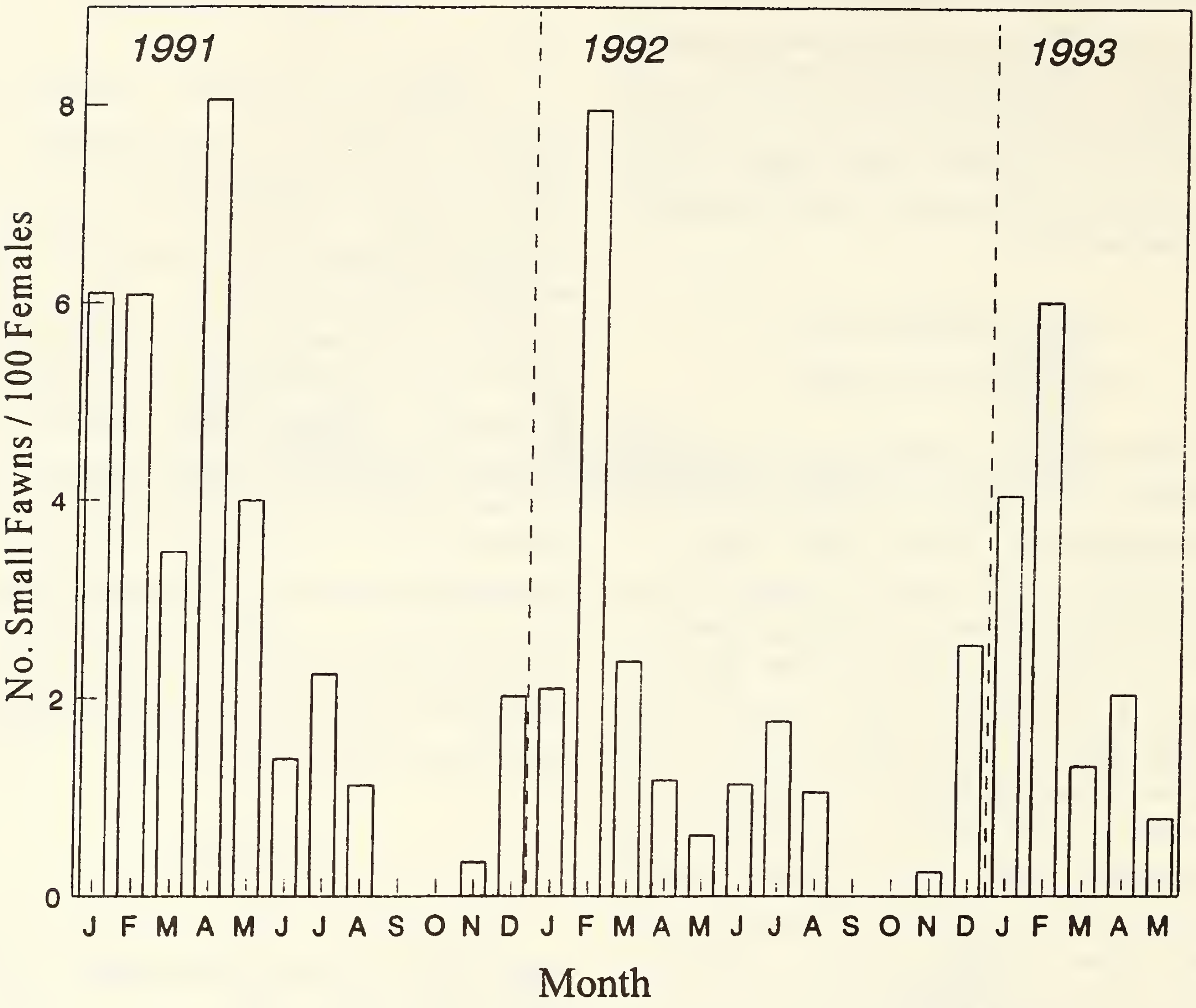

Fig. 5: Seasonality of fawning in chital in Guindy National Park from 1991-93.

antler) earlier and produce larger antlers than subordinate ones (Bartoš 1990). Yearling male chital have also been reported to come into hard antler several months after the peak in the adult rut (Fuchs 1977, Schaller 1967, Schaller and De 1971). Age-related differences in antler cycles and rutting have been noted in other Indian deer species: the swamp deer or barasingha (*Cervus duvauceli duvauceli* — young stags cast antlers later in the year, Singh 1984, and my personal observation), the hardground barasingha (*C. d. branderi* — young stags rut later than adults, Martin 1975), and the sambar (*C. unicolor* — young males cast antlers later than adults, Richardson 1972). In spite of the occasional description of these patterns, the processes underlying them remain poorly understood. Here I discuss the factors influencing the breeding seasonality patterns in male and female chital, and compare these with other cervids.

Age-related antler cycles and reproduction in males

It is well established that the hard antler stage in tropical and temperate cervids is associated with high testosterone levels, enlarged testes, and heightened sexual activity in males (Goss 1983, Lincoln 1985, 1992b, *Axis axis*: Loudon and Curlewis 1988). The rut is an energetically expensive period for males of different species due to the demands of territorial defence, mate searching, bellowing, sparring and fighting activities (Clutton-Brock *et al.* 1979,

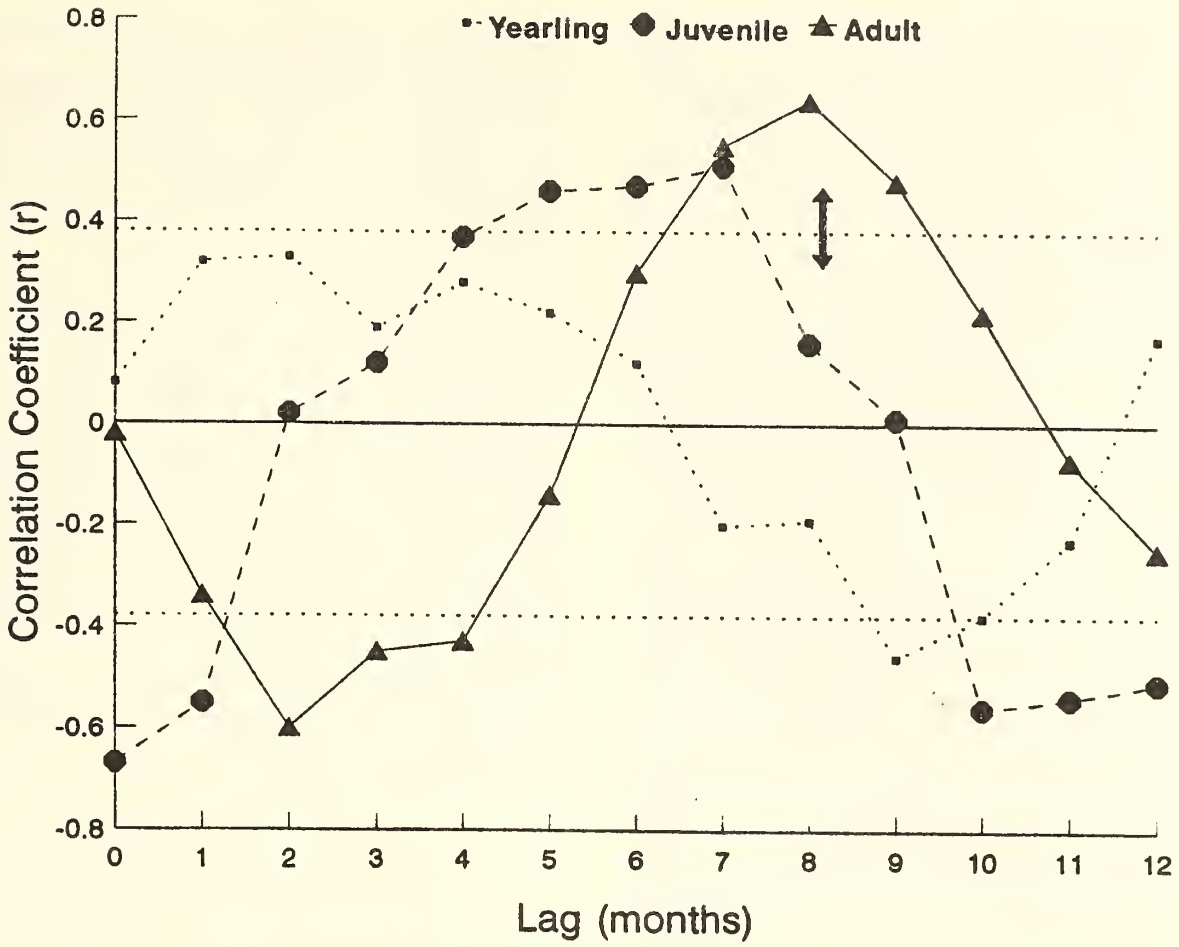

Fig. 6: Time-lag correlations between the monthly percentage of hard antlered males of different age classes and fawning. Pearson product-moment correlation values falling outside the range encompassed by the horizontal dotted lines are significant (2-tailed $P < 0.05$)

1982, Barrette 1987, de Vos *et al.* 1967, Schaller 1967) resulting in weight loss (Mitchell *et al.* 1976, Loudon and Curlewis 1988), stress (Bronson 1989), and injuries including mortal wounds (Clutton-Brock 1982, Clutton-Brock *et al.* 1979, 1982, Miura 1984b). In chital, bodily injury to males in vicious fights was observed in 18 of 74 instances in Texas (Fuchs 1977) and a high frequency of antler breakage was also noted (Barrette 1985, Fuchs 1977). Also, older hard-antlered male chital are more susceptible to predation than younger males (Johnsingh 1983, Patel 1992).

These observations are important when considering age-related differences in antler cycles. In GNP, by the end of May, nearly 70-80% of the adult males have been rutting for two months, and a further 5-10% have been rutting for a month. Thus in June, when most juvenile males attain hard antler, a majority of adult males are relatively exhausted from their rutting activities. If any females are in oestrus at this time or later, the chances for juvenile males to succeed in courtship may be higher. In fact, chital females are known to have a series of oestrus cycles throughout the year in captivity (Asdell 1964). Females that fail to conceive during the main rut of adult males, cycle again at intervals of about 19 days (English 1992), and may mate with juvenile or yearling males later in the year, when most adults are in velvet. Similarly, in red deer and reindeer, sub-adult stags achieve little success in obtaining and copulating with oestrus hinds during the mating peak of adult stags (Gibson and Guinness 1980, Hirotani 1994), but young stags that hold hinds later, when most adults are exhausted, achieve copulation (Clutton-Brock *et al.* 1982, Hirotani 1994). This is also analogous to *musth* in African elephants *Loxodonta africana*, where younger males often stagger their *musth* from large bulls, and are then able to dominate them in fights over oestrus females or access to resources (Poole 1989).

Thus, the staggered age-specific patterns of antler cycles can be a strategy to avoid intrasexual conflict among males. This may apply particularly in areas which have a high density of chital such as GNP (212.3 individuals/km^2, Raman *et al.* 1996). Another explanation given for such age-specific patterns of rutting is that the timing of antler development may be determined ontogenetically, so as to enable individual males to come into hard antler at the time of the main rut, when they attain adulthood (Dunbar-Brander 1931, Schaller 1967). This, however, does not appear to hold true, since in the lower-density (18.9 chital/km^2) free-ranging population of chital in Texas, Fuchs (1977) found that only yearling males differed in antler cycles from other males, whereas juvenile males were more or less synchronous with adult males. It is speculated that there may be flexible variation in antler cycles of males in different populations depending on the intensity of male-male conflict.

Younger males may stagger their antler cycles only if they are able to derive the benefits of conflict avoidance and attaining copulation. It was not within the scope of the present study to examine copulatory success of males of different age classes. Earlier studies have, however, shown that juvenile male chital do achieve copulation under free-ranging conditions (Barrette 1987). About 90% (61 of 68) of the copulations documented in the literature were achieved by the big male class (antler length > 60 cm), 6% (4) by medium males (antler length 30-60 cm), 4% (3) by juvenile males (antler length < 30 cm), and none by yearling males (Barrette 1987). From the female's point of view, mating with a younger male may be better than not mating at all in a given year. Conversely, younger males too could be of high quality and females could mate with young males which possess attributes that are relatively high-quality for their age (Clutton-Brock *et al.* 1982). Further studies are, however, required to produce direct behavioural evidence that can support or reject the contention that staggering of antler cycles by younger males in chital is a strategy to offset male-male conflict and attain higher reproductive success.

An offshoot of the age-specific patterns of rutting may be the slightly diffuse nature of the fawn birth pulse. Another reason for this is probably that seasonality in the tropics is less sharp than in temperate regions. Male fawns born outside the birth peak may contribute to the small proportion of 'floating' males which have their antler cycles out of phase with other males of their age class. The time of the year when males of different age classes rut is probably constrained by female breeding seasonality.

Female breeding seasonality

Given a gestation period of about 8 months in chital (English 1992: 235 days, SD = 3.0, Rao 1984: 236-247 days, $N = 5$), the results indicate that most conceptions occurred in May-June, corresponding to the peak in rutting of adult males (Fig. 2d). That adult males are responsible for most of the conceptions is supported by the significant correlation between the adult male rut and fawning at a lag of 8-9 months. Weaning of fawns occurs 3-4.5 months after birth (Graf and Nichols 1966) and the mean time between birth and the next conception has been estimated to be 48 days in captivity (English 1992) and 4-5 months in the wild (Graf and Nichols 1966). Females with big fawns close to weaning age are frequently observed being courted by chital males (Barrette *pers. comm.* and my own observation). Thus in GNP, weaning of most fawns and conceptions occur around May-June during the adult male rutting peak.

Female deer usually undergo parturition during periods that are most favourable for fawn survival, usually in terms of high food availability (Delany and Happold 1979, Robbins *et al.* 1987; Sempéré 1990). In GNP, however, most births occur between late December and early March, which is the onset of the dry season, a period of relative resource scarcity (Fig. 1). Observing similar seasonality in Bandipur, Sharatchandra and Gadgil (1975) suggested that females pursue this strategy as it entails pregnancy during the wet season, when food is abundant. In female deer and other ruminants, however, the energy needs of lactation are known to exceed those of pregnancy (Bronson 1989, Loudon and Brinklow 1992, Loudon and Kay 1984, Robbins *et al.* 1987, Widdowson 1981). The late-lactation period is, therefore, likely to be crucial both for maternal survival and investment in offspring. While quantitative data are lacking on chital feeding ecology and nutritional energetics, it is suggested that, in places such as GNP and Bandipur, parturition by females at the onset of the dry season enables them to coincide their period of late-lactation with the flush of plant growth following pre-monsoon showers. After weaning, the fawns begin to feed on the grasses from the southwest monsoon rains. Pregnant females can then meet the needs of foetal development through the wet season, and store reserves for the needs of the dry season, birth, and early lactation (Sharatchandra and Gadgil 1975).

The influence of rainfall and food availability can be tested on different chital populations. It can be predicted that in north India, where the monsoon occurs about a month later, breeding would be delayed. Available reports as well as this study partially support this conjecture. Thus chital in Bandipur and GNP at 13°N have a rutting peak in May-June (Johnsingh 1983, Sharatchandra and Gadgil 1975), while in Corbett National Park at 29°N it is in June-July (Tak and Lamba 1984). In Chitwan National Park at the same latitude, however, the peak rut is in April-May (Mishra and Wemmer 1987), which may be due to early pre-monsoon rains in April-May or due to factors other than rainfall. Interestingly, in Wilpattu National Park in Sri Lanka where there are two distinct rainy seasons, there are two corresponding fawning seasons in the chital population (Eisenberg and Lockhart 1972, Barrette *pers. comm.*). Quantitative description of such patterns in future studies using sinusoidal curves as presented in this study will enable comparison of biologically relevant parameters across populations. Studies of captive herds coupled with long-term field studies can yield comprehensive insights into the factors affecting the reproduction of tropical cervids.

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SPECIES COMPOSITION, STATUS AND FEEDING ECOLOGY OF AVIFAUNA IN HIGH ALTITUDE FORESTS OF SRI LANKA[1]

K.B. Ranawana and C.N.B. Bambaradeniya[2]

(*With four text-figures*)

Key words: Hakgala Strict Nature Reserve (HSNR), Horton Plains National Park (HPNP), Peak Wilderness Sanctuary (PWS), avifauna, beta diversity, species composition, feeding guilds.

A survey was carried out from May to October 1995, to investigate the species composition, status and feeding ecology of bird communities in three high altitude forests of Sri Lanka, namely Hakgala Strict Nature Reserve (HSNR, 1142 ha), Horton Plains National Park (HPNP, 3160 ha) and the Peak Wilderness Sanctuary (PWS, 22,380 ha). Altogether, 116 species of birds were recorded during this survey, including 13 species of winter migrants and 23 species that are endemic to Sri Lanka. The number of bird species observed at HSNR, HPNP and PWS were 61, 47 and 98 respectively. Results indicate that the avifauna at PWS has a high species richness. Beta diversity measurements also indicate that the avifauna at PWS is more diverse, as compared to HSNR and HPNP, whose avifaunal communities show a higher degree of similarity. Seventeen food defined guilds were identified among the bird species. The fact that 21 species of birds (19.5%) observed during this survey are nationally threatened today, points to the importance of conserving these few remaining high altitude forest patches, thereby ensuring the survival of these vulnerable species.

INTRODUCTION

Sri Lanka, with a varied landscape and a diversity of habitats, harbours a rich bird life. 427 species of birds have been recorded to date from the island, which include 169 winter migrants (Phillips 1978), and 26 endemic species (Wijesinghe 1994). A majority of the endemics are confined to the wet southwestern areas of the island (Wijesinghe *et al.*1993). Some studies have been carried out previously on the species composition, ecology and status of avifauna especially in the low country wet and dry zones of Sri Lanka (Kotagama and Thambiah 1986, Jansen *et al.* 1986). However, information on the montane zone avifauna of Sri Lanka is scarce. Werner and Schwienfurth (1985) recorded many species of birds that are endemic to Sri Lanka from two montane zone forests — the Peak Wilderness Sanctuary and Horton Plains.

The present study was carried out in three high elevation wet zone forests of Sri Lanka, namely the Hakgala Strict Nature Reserve (HSNR, 1142 ha), Horton Plains National Park. (HPNP, 3160 ha), and the Peak Wilderness Sanctuary (PWS, 22,380 ha). The HSNR (1650 m - 2178 m above msl) lies on the south bank of Sita Eliya and consists of a botanically rich montane cloud forest (IUCN 1990). It also contains some patches of montane grasslands. The HPNP (1800 m - 2289 m above msl), which adjoins the eastern edge of the PWS, comprises of a gently undulating highland plateau which supports wet montane grassland, fringed and interspersed with patches of dense montane cloud forest (IUCN 1990). The PWS (50 m - 2230 m above msl) consists of three major forest

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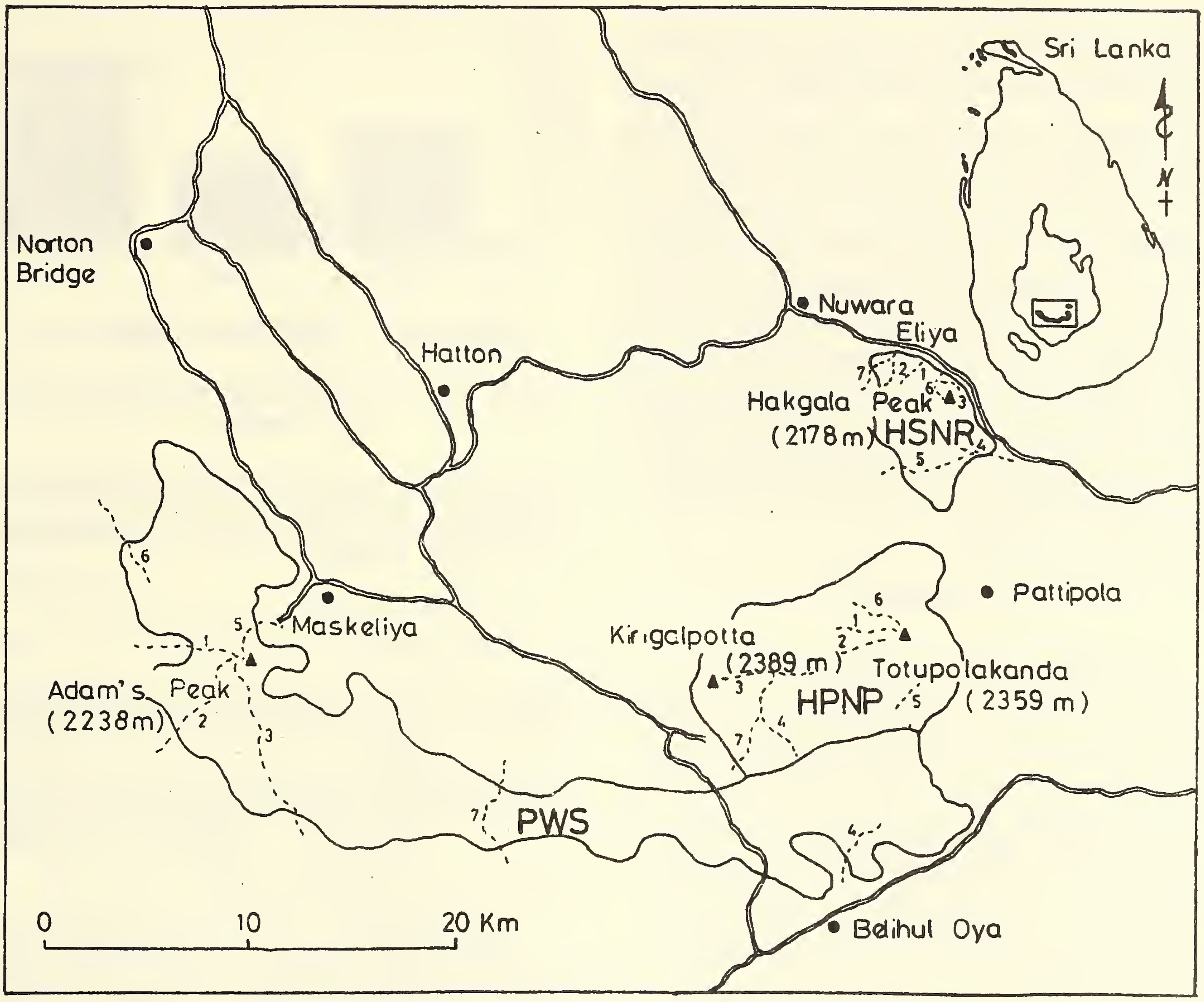
Sri Lanka
N
Norton Bridge
Hatton
Nuwara Eliya
Hakgala Peak
(2178 m)
HSNR
Pattipola
Maskeliya
Kirigalpotta
(2389 m)
Totupolakanda
(2359 m)
HPNP
Adam's Peak
(2238m)
PWS
Belihul Oya
0
10
20 Km
1
2
3
4
5
6
7

Fig. 1: Map showing the protected areas studied for avian communities

······	Study trails
═	Main Road
〜	Forest Boundary
PWS	Peak Wilderness Sanctuary
HPNP	Horton Plains National Park
HSNR	Hakgala Strict Nature Reserve

HSNR	01	Licence bridge - Seetha Eliya - 2 km
	02	Kande Ela - Seetha Eliya - 1.5 km
	03	Hakgala Botanical gardens border - 1 km
	04	Warwick Estate border - 1 km
	05	Ambewela NLDB farm border - 1 km
	06	Hakgala Peak trail - 1.5 km
	07	Kande Ela tank border - 1 km
HPNP	01	Thotupolakande peak trail - 1.5 km
	02	Dayagama Road - 2 km
	03	Kirigalpotta peak trail - 4 km
	04	World's end trail - 1 km
	05	Wet montane grasslands - 1 km
	06	Grassland & forest edge - 1 km
	07	Baker's Falls - 1.5 km
PWS	01	Eratne-Adam's Peak - 5 km
	02	Palabathdela - Adam's Peak - 8 km
	03	Hapugastenna - Adam's Peak - 7 km
	04	Belihul Oya - Ihala Galagama - 3 km
	05	Moray Estate - Adam's Peak - 4 km
	06	Maliboda - 2 km
	07	Mihiriyakotte-Waleboda - 5 km

formations which are contiguous and altitudinally graded; the lowland rainforest (50 m -700 m), the sub-montane rainforest (700 m - 1700 m) and the montane cloud forest (>1700 m). All three forests lie within the montane wet zone of Sri Lanka. Details of topography, vegetation and climate of these areas is given in the IUCN Directory of South Asian Protected Areas (1990).

The main objective of the study was to compare the species composition and diversity of bird communities in these three high elevation forests of Sri Lanka, and to study the habitats and feeding ecology of the bird communities in the same three forests.

METHODOLOGY

The study was conducted from May to October 1995. Bird communities in each of the three forests were investigated along seven predetermined trails respectively (Fig. 1), covering all major habitat types (forests, scrublands, grasslands and aquatic habitats). The length of a single trail varied between 1-8 km (App. I).

Birds were observed from early morning (0600 h) till late evening (1830 h) and approximately 350 man hours were spent at each forest. Identification of the birds was based on Henry (1978) and Kotagama and Fernando (1994). Species nomenclature follows Phillips (1978).

Using the presence/absence data (qualitative data), the degree of change (variation) in species composition between the forests was calculated for each forest, using Whittaker's measure:

$$ßw = S/\text{alpha} - 1$$

where S = the total number of species recorded in a forest, and

alpha = mean species richness or mean number of species per trail (Magurran 1988).

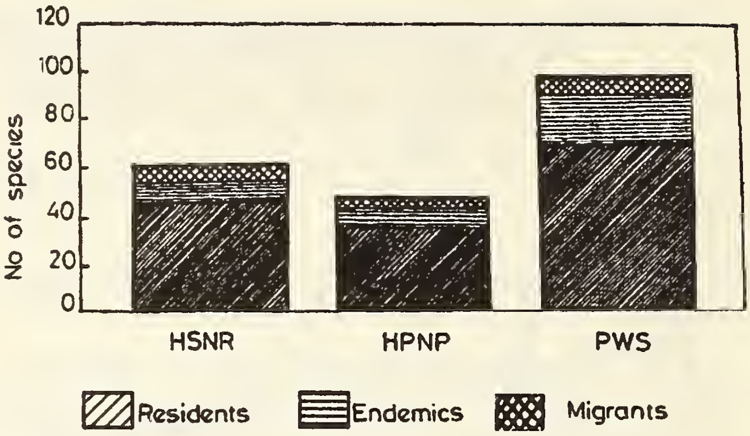

Fig. 2: Status comparison of avifauna at the study areas

The degree of similarity of two forests (where bird species are concerned), was investigated using Jaccard's measure of estimating ß diversity:

$$C_J = j/_{(a+b-j)}$$

where j = the number of species found at both sites

a = the number of species in forest A

b = the number of species in forest B (Magurran 1988)

The different species of birds observed in the forests were divided according to their main feeding categories, under which food defined guilds were also recognized and separated. The proportion of birds in each feeding category and the proportion of birds in the main habitat types were calculated separately for each study area.

RESULTS

A total of 116 species belonging to 37 families were recorded from the three forests (App. II). These included 13 species of winter migrants and 23 species that are endemic to Sri Lanka. Fig. 2 shows a comparison of the status of the avifauna at the above forests. The total number of bird species observed at HSNR, HPNP and PWS were 61, 47 and 98 respectively. The proportions of endemic bird species recorded as a percentage of the total number of endemic bird species in Sri Lanka were as follows: HSNR 30%

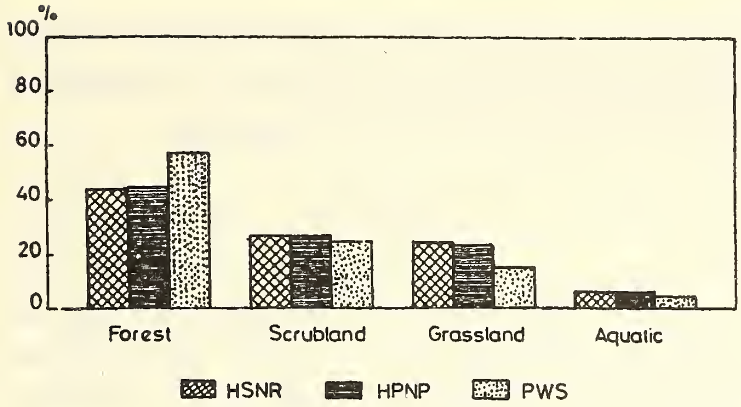

Fig. 3: Percentage habitat occupation of birds in the study areas

(8 species), HPNP 27% (7 species) and PWS 77% (20 species). The winter migrants arrived in late September.

Each study area consisted of four main habitat types — forests, scrublands, grasslands and aquatic habitats such as marshes, streams and ponds. Fig. 3 shows the percentage habitat occupation of birds in the three study areas. The habitat occupation of birds at HSNR and HPNP appears to be similar.

The mean number of species per trail at each study area included: HSNR 25.84 ± 4.81 (SD), HPNP 21.85 ± 5.11 and PWS 39.71 ± 12.89 (App. I). Table 1 shows the beta diversity measurements (Whittaker's index/Jaccard's index) for the three study areas. The higher values of Whittaker's index indicate a greater variation in species composition in a community, while higher values of Jaccard's index indicate greater similarity between bird communities in the two forests.

TABLE 1
BETA DIVERSITY MEASUREMENTS

Forest	HSNR	HPNP	PWS
Total no. of bird species	61	47	98
Mean no. of species per trail	25.84±4.81	21.85±5.11	39.71±12.89
Whittaker's measure	1.35	1.15	1.46
Forest pairs	HSNR & HPNP	HSNR & PWS	HPNP & PWS
Total no. of species common to each forest pair	41	47	36
Jaccard's measure	0.61	0.41	0.33

The species composition in the three study areas is clearly shown in Fig. 4. Forty nine (42.2%) bird species observed were exclusive to PWS, seven species (6.0%) were exclusive to HSNR and four species (3.4%) were exclusive to HPNP. Seven species were recorded only at HSNR and HPNP, two species were recorded only at HPNP and PWS, 13 species were recorded only at HSNR and PWS while 34 (29.3%) species were common to all three forests. Of the 49 species of birds exclusive to Peak Wilderness Sanctuary, 40 species occurred below 1500 m altitude.

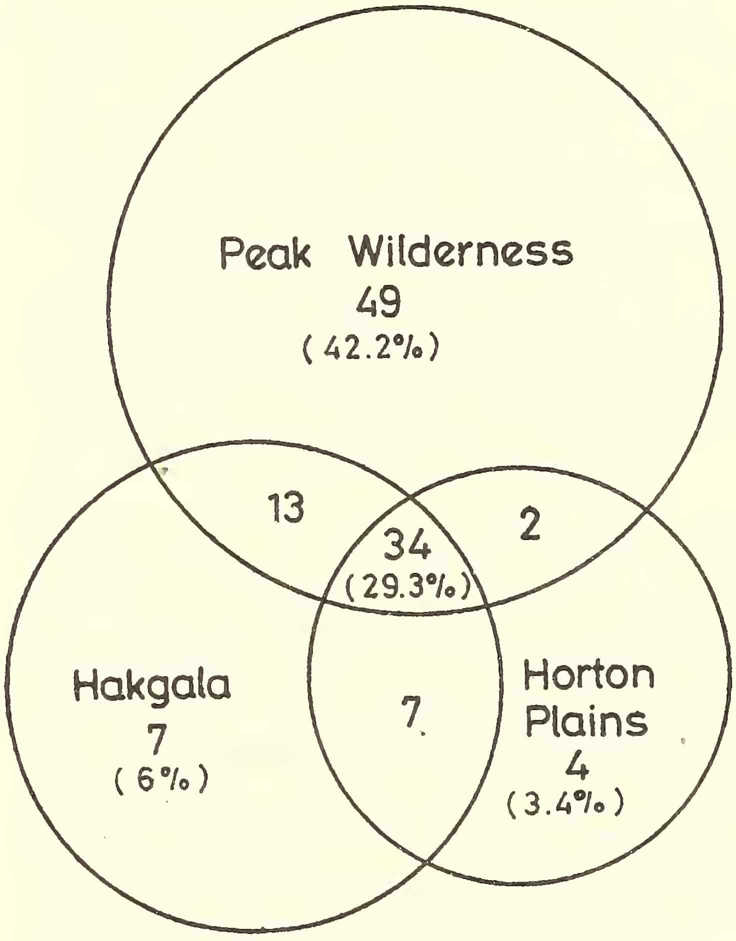

Fig. 4: Species composition of avifauna at the study areas. Showing the no. of exclusive and common species

Many species of birds were observed feeding in social groups (single species flocks and mixed species flocks). Mixed species foraging bird flocks was a common observation

TABLE 2
PROPORTION OF BIRD SPECIES OBSERVED ACCORDING TO THEIR FEEDING GUILDS

Food category	No. of feeding guilds*	HSNR	HPNP	PWS
Insectivorous	06	35 (57.3%)	26 (55.3%)	44 (45%)
Carnivorous	03	7 (11.4%)	7 (14.8%)	11 (11.2%)
Phytophagous	04	10 (16.39%)	7 (14.89%)	25 (25.5%)
Omnivorous	04	9 (14.75%)	7 (14.89%)	18 (18.3%)

* Refer Appendix II for feeding guilds

at all three forests. Altogether, 35 species were observed participating in mixed flocks (App. II). Here, a single flock consisted of 4 to 20 different species with 10 to 60 individual birds. The lowland rainforest area of the Peak Wilderness Sanctuary harboured a higher number of flocks with mixed species as compared to the other areas. The different species of birds comprising the mixed flocks were distributed according to the vertical stratification of the vegetation.

The proportion of bird species according to four major feeding categories and the number of feeding guilds recognized under each feeding category is given in Table 2.

The insectivorous birds can be divided into six feeding guilds, based on their profitable/ preferable feeding sites/niches. Similarly, carnivorous birds can be divided into three feeding guilds. The table shows that both HPNP and HSNR harbours a higher proportion of birds which feed on animal matter (approximately 70% insectivorous + carnivorous), compared to those at PWS (approximately 56%). Birds at the PWS occupy a considerable proportion of the phytophagous category (25%) (divided into four guilds) compared to those of the other two forests. However, the majority of the species from this category were found only in the lowland and sub-montane rain forest areas of the Peak Wilderness Sanctuary. A similar trend is seen in the omnivorous category (four guilds) where 19% of the birds at PWS belong to this category.

Appendix II provides a checklist of birds for the three study areas along with their feeding guilds, habitats, habits (solitary, pairs, flocks, and mixed flocks) and feeding strategies.

DISCUSSION

With respect to the degree of change in species composition between the forests (ß diversity - Whittaker's Index), the avifauna at PWS shows greater diversity and variation in comparison to the avifauna of the other two forests.

The main reason for this is likely to be the contiguous tracts of altitudinally graded forest, ranging from lowland rainforest to high altitude cloud forest. This is further evident when considering the percentage habitat occupation of birds in the three study areas. The percentage of birds occupying the forest habitats is highest at PWS (57%). The majority of bird species observed here were in the lowland rain forest area (50 m-700 m), which consists of a continuous 30-40 m high canopy, interspersed by taller individual emergents rising to about 60 m. The rich flora in the lowland rainforest creates additional habitats and food resources, and thereby harbours a diverse avifauna with many phytophagous species. The number of bird species observed gradually decreased along with increasing altitude. This may be due to the change in vegetation, food resources and cold climate at higher altitudes. The Jaccard's measure indicates that the avifaunal communities at HSNR and HPNP have a higher degree of similarity, compared to those at PWS and HPNP, and PWS and HSNR. Both HPNP and HSNR consist of montane cloud forest and montane grassland situated above 1650 m, and this may be the reason for the higher degree of similarity of avifauna in these two forests.

The food defined guild structure of the birds observed (Table 1, App. II) highlights the efficient distribution of food resources among different species in a community. It was evident that the different species of birds occupying a particular feeding guild and space had evolved specialized feeding strategies to explore and obtain food resources efficiently and thereby reduce competition within a guild (App. II). For instance, of the arboreal insectivores occupying the canopy and sub-canopy, some were fast-flying, hawking (ie. Grey-headed flycatcher) while others were slow-flying, hawking (Azure blue flycatcher, Dusky blue flycatcher). Of the bark-gleaning insectivores in tree trunks, some chisel and drill into bark (woodpeckers), while others probe into lichens and mosses on tree trunks and into crevices (i.e. scimitar babbler, grey tit). These different feeding strategies are directly related to the structural adaptations of each species (i.e. structure of bill, legs and feet, wings etc.) Bird species which feed in flocks may have the advantage of finding food with ease and also protection. It was observed that birds which fed in social groups exploited food resources that were patchily distributed in both space and time (insects, seeds, fruit etc.), while most solitary feeders consumed well dispersed animal prey (amphibians, reptiles, mammals, snails, etc.). The majority of species in mixed flocks were insectivorous.

Of the total number of bird species observed in these three forests, 21 (19.5%) are considered as threatened in Sri Lanka (Wijesinghe *et al.* 1993). The Peak Wilderness Sanctuary, in particular, harbours the majority of the endemic and threatened bird species of Sri Lanka. These facts underline the importance of protecting these three forests in order to ensure the survival of these vulnerable bird species.

Finally, an aspect that was not examined during this survey was quantitative data on numbers of different species in a community, which would lead to the estimation of avifaunal diversity and relative abundance within each forest. We intend doing so in a future survey.

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Appendix 1

NUMBER OF BIRD SPECIES RECORDED IN DIFFERENT TRAILS

	Trail No.	Trail & length	Total number of birds observed	Number of new species observed	Cumulative total of species
HSNR	01	Licence bridge - Seetha Eliya - 2 km	21	21	21
	02	Kande Ela - Seetha Eliya - 1.5 km	28	11	32
	03	Hakgala Botanical gardens border - 1km	22	07	39
	04	Warwick Estate border - 1 km	22	04	43
	05	Ambewela NLDB farm border - 1 km	31	07	50
	06	Hakgala Peak trail - 1.5 km	24	02	52
	07	Kande Ela tank border - 1 km	33	09	61
			Mean no. of species per trail 25.85 ± 4.81 (SD)		
HPNP	01	Thotupolakande peak trail - 1.5 km	20	20	20
	02	Dayagama Road - 2 km	26	08	28
	03	Kirigalpotta peak trail - 4 km	30	09	37
	04	World's end trail - 1 km	18	01	38
	05	Wet montane grasslands - 1 km	15	02	40
	06	Grassland & forest edge - 1km	24	02	42
	07	Baker's Falls - 1.5 km	20	05	47
			Mean no. of species per trail 21.85 ± 5.11		
PWS	01	Eratne-Adam's Peak - 5 km	40	40	40
	02	Palabathdela - Adam's Peak - 8 km	51	18	58
	03	Hapugastenna - Adam's Peak - 7 km	52	20	78
	04	Belihul Oya - Ihala Galagama - 3 km	20	03	81
	05	Moray Estate - Adam's Peak - 4 km	30	06	87
	06	Maliboda - 2 km	32	03	90
	07	Mihiriyakotte-Waleboda - 5 km	53	08	98
			Mean no. of species per trail 39.71 ± 12.89		

Appendix II

BIRD SPECIES OBSERVED AT THE HAKGALA SNR, HORTON PLAINS NP & PEAK WILDERNESS SANCTUARY AND THEIR HABITATS AND FEEDING ECOLOGY

(Common names as provided by author - Ed.)

Feeding guild & habitat	Family Common name Scientific name	HSNR	HPNP	PWS	Habit/ Feeding Strategy
ABI F	**Muscicapidae** Dusky-blue flycatcher*+ *Eumyias sordida (Muscicapa)*	X	X	X	S, MF/ slow flying -hawking
F/S	Grey-headed flycatcher *Culicicapa ceylonensis*	X	X	X	P, F, MF/ fast flying- hawking

Appendix II (contd.)

BIRD SPECIES OBSERVED AT THE HAKGALA SNR, HORTON PLAINS NP & PEAK WILDERNESS SANCTUARY AND THEIR HABITATS AND FEEDING ECOLOGY
(Common names as provided by author - Ed.)

Feeding guild & habitat	Family Common name Scientific name	HSNR	HPNP	PWS	Habit/ Feeding Strategy
F/S	Orange-breasted blue flycatcher *Cyornis tickelliae*	-	-	X	S, MF/ hawking gleaning
F	Azure-blue flycatcher *Hypothymis azurea*	X	-	X	S, MF/fast flying-hawking
F/S	Whitebrowed fantail flycatcher *Rhipidura aureola*	X	-	-	S/slow flying hawking
F	Indian paradise flycatcher (WM) *Terpsiphone paradisi*	-	-	X	S/slow flying-hawking
F	Kashmir flycatcher (WM) *Ficedula subrubra* (*Musicapa*)	X	-	-	S/snapping
F	Brown flycatcher (WM) *Muscicapa daurica*	X	-	X	S/snapping
F	**Dicruridae** Crested drongo *Dicrurus paradiseus*	-	-	X	P, MF/ diving & hawking
F/S	White vented drongo *Dicrurus caerulescens*	-	-	X	S, MF/diving & hawking
F	**Trogonidae** Trogon + *Harpactes fasciatus*	-	-	X	S, MF/slow flying, hawking
F/S	**Caprimulgidae** Highland nightjar *Caprimulgus indicus*	X	X	X	S/fast flying hawking
F/S	**Lanidae** Brown shrike (WM) *Lanius cristatus*	X	-	X	S/fly and pick
AI G/S	**Apodidae** Edible nest swiftlet *Collocalia unicolor*	X	X	X	F/gliding, hawking
G/S	House swift *Apus affinis*	-	-	X	F/gliding, hawking

Appendix II (contd.)

BIRD SPECIES OBSERVED AT THE HAKGALA SNR, HORTON PLAINS NP & PEAK WILDERNESS SANCTUARY AND THEIR HABITATS AND FEEDING ECOLOGY
(Common names as provided by author - Ed.)

Feeding guild & habitat	Family Common name Scientific name	HSNR	HPNP	PWS	Habit/ Feeding Strategy
F/S	Crested tree swift *Hemiprocne coronata*	-	-	X	S, P/gliding, hawking
	Hirundinidae				
F/S	Hill swallow *Hirundo domicola*	X	X	X	F/gliding, hawking
G/S	Red-rumped swallow *Hirundo daurica*	-	-	X	F/gliding, hawking
G/S	East Asian swallow (WM) *Hirundo rustica*	X	X	X	F/gliding, hawking
	Meropidae				
F/G/S	Chestnut-headed bee eater *Merops leschenaulti*	-	-	X	S, P/fast flying, hawking
FGI	**Muscicapidae**				
F/G/S	Tailor bird *Orthotomus sutorius*	X	X	X	P, MF/gleaning
F	Large-billed leaf warbler (WM) *Phylloscopus magnirostris*	X	X	X	S/gleaning
F	Shama *Copsychus malabaricus*	-	-	X	S/glean, snap
	Campephagidae				
F	Orange minivet *Pericrocotus flammeus*	X	X	X	P, F, MF/ gleaning
F	Little minivet *Pericrocotus cinnamomeus*	X	X	X	F, MF/ gleaning
F	Pied flycatcher shrike *Hemipus picatus*	X	X	X	F, MF/ gleaning
	Irenidae				
F/S	Iora *Aegithina tiphia*	-	-	X	P/gleaning
BGI	**Sittidae**				
F	Velvet fronted blue-nuthatch *Sitta frontalis*	X	X	X	F, MF/pecking, probing

Appendix II (contd.)

BIRD SPECIES OBSERVED AT THE HAKGALA SNR, HORTON PLAINS NP & PEAK WILDERNESS SANCTUARY AND THEIR HABITATS AND FEEDING ECOLOGY
(Common names as provided by author - Ed.)

Feeding guild & habitat	Family Common name Scientific name	HSNR	HPNP	PWS	Habit/ Feeding Strategy
F/G/S	**Paridae** Grey tit *Parus major*	X	X	X	P, F, MF/ probing
F	**Picidae** Red backed woodpecker *Dinopium benghalense*	-	-	X	P, MF/drilling, probing
F	Crimson-backed woodpecker *Chrysocolaptes lucidus*	X	X	X	P, MF/drilling, probing
F	Scaly bellied-green woodpecker+ *Picus xanthopygeus (myrmecophoneus)*	X	X	X	P/drilling, probing
F	Yellownaped woodpecker *Picus chlorolophus*	-	-	X	P/drilling, probing
F	**Muscicapidae** Scimitar babbler *Pomatorhinus horsfieldii*	X	X	X	P, F, MF/ probing
TI F/S	**Muscicapidae** Brown capped babbler* *Pellorneum fuscocapillum*	-	-	X	F/pick
F/S	Black fronted babbler *Rhopocichla atriceps*	X	X	X	F, MF/pick
F/G/S	White throated babbler *Dumetia hyperythra*	-	-	X	F/pick
F	Rufous babbler*+ *Turdoides rufescens*	-	X	X	F, MF/pick
F/G/S	Sri Lanka warbler*+ *Bradypterus palliseri*	X	X	X	P/pick
F	Spotted winged thrush*+ *Zoothera spiloptera*	-	-	X	S/pick
F/Aq	Arrenga*+ (Whistling thrush) *Myiophonus blighi*	X	-	-	S/pick

Appendix II (contd.)

BIRD SPECIES OBSERVED AT THE HAKGALA SNR, HORTON PLAINS NP & PEAK WILDERNESS SANCTUARY AND THEIR HABITATS AND FEEDING ECOLOGY
(Common names as provided by author - Ed.)

Feeding guild & habitat	Family Common name Scientific name	HSNR	HPNP	PWS	Habit/ Feeding Strategy
F/G/S	Blackbird *Turdus merula*	X	X	-	S/pick
F/G	Magpie robin *Copsychus saularis*	X	-	X	S/pick
F	Pied ground thrush (WM) *Zoothera wardii*	-	-	X	S/pick
F/S	**Pittidae** Indian pitta (WM) *Pitta brachyura*	-	-	X	S/pick
GI G/Aq	**Charadriidae** Red wattled lapwing *Vanellus indicus*	-	X	-	P/pick
G	**Alaudidae** Oriental skylark *Alauda gulgula*	X	X	-	P/pick
G/S	Indian pipit *Anthus rufulus*	X	X	-	S/pick
F/G/Aq	**Motacillidae** Grey wagtail (WM) *Motacilla cinerea*	X	X	X	S/pick
F/G	Yellow wagtail (WM) *Motacilla flava*	X	-	-	S/pick
G/S	**Muscicapidae** Pied bush chat *Saxicola caprata*	X	X	-	P/pick
G/S	Fan tailed warbler *Cisticola juncidis*	X	X	-	S/pick
G/S	Large prinia *Prinia sylvatica*	X	-	-	S/pick
G/S	White browed prinia *Prinia inornata*	X	-	X	S/pick

Appendix II (contd.)

BIRD SPECIES OBSERVED AT THE HAKGALA SNR, HORTON PLAINS NP & PEAK WILDERNESS SANCTUARY AND THEIR HABITATS AND FEEDING ECOLOGY
(Common names as provided by author - Ed.)

Feeding guild & habitat	Family Common name Scientific name	HSNR	HPNP	PWS	Habit/ Feeding Strategy
G/S	Ashy prinia *Prinia socialis*	X	-	X	S/pick
AC	**Accipitridae**				
F/G/Aq	Black-winged kite *Elanus caeruleus*	X	X	X	S/hovering, diving
F/G	Serpent eagle *Spilornis cheela*	X	X	X	P/soaring, diving
F/G/S	Black eagle+ *Ictinaetus malayensis*	-	X	-	S/soaring, diving
F/G	Mountain hawk-eagle+ *Spizaetus nipalensis*	X	X	-	S/soaring, diving
F/G/Aq	Pale harrier (WM) *Circus macrourus*	-	X	-	S/soaring, diving
F/G/Aq	Marsh harrier (WM) *Circus aeruginosus*	-	X	-	S/soaring, diving
ATC F/G/S	Shikra *Accipiter badius*	-	-	X	S/fly, grab
	Strigidae				
F	Jungle owlet *Glaucidium radiatum*	-	-	X	S/fly, grab
F/Aq	Fishing owl *Bubo zeylonensis*	-	-	X	S/fly, grab
	Corvidae				
F	Sri Lanka blue magpie*+ *Urocissa ornata*	-	-	X	P, F/search, grab
	Alcedinidae				
G/Aq	White-breasted kingfisher *Halcyon smyrnensis*	X	-	X	S/fly, pick
	Cuculidae				
F/S	Common coucal *Centropus sinensis*	X	X	X	S/search, pick
F	Green billed coucal*+ *Centropus chlororhynchus*	-	-	X	S/search, pick

Appendix II (contd.)

BIRD SPECIES OBSERVED AT THE HAKGALA SNR, HORTON PLAINS NP & PEAK WILDERNESS SANCTUARY AND THEIR HABITATS AND FEEDING ECOLOGY
(Common names as provided by author - Ed.)

Feeding guild & habitat	Family Common name Scientific name	HSNR	HPNP	PWS	Habit/ Feeding Strategy
WC	**Charadriidae**				
Aq	Common sandpiper (WM) *Tringa hypoleucos*	X	-	-	S/walk, pick
	Ardeidae				
Aq	Pond heron *Ardeola grayii*	X	-	X	S/walk, pick
Aq	Little egret *Egretta garzetta*	-	-	X	S/walk, pick
AN	**Nectariniidae**				
F	Purple sunbird *Nectarinia asiatica*	X	X	X	P, MF/hover, suck nectar
F/S	Purplerumped-sunbird *Nectarinia zeylonica*	X	X	X	P/hover, suck nectar
F	Loten's sunbird *Nectarinia lotenia*	-	-	X	P/hover, suck nectar
AF	**Sturnidae**				
F	Common grackle *Gracula religiosa*	-	-	X	P, F/pluck
F	Sri Lanka grackle*+ *Gracula ptilogenys*	-	-	X	P, F, MF/pluck
	Columbidae				
F	Pompadour green pigeon *Treron pompadora*	-	-	X	F, MF/pluck
F	Green imperial pigeon *Ducula aenea*	-	-	X	P, F, MF/pluck
F	Sri Lanka wood pigeon*+ *Columba torringtoni*	X	X	-	S, P/pluck
	Dicaeidae				
F/S	Tickell's flowerpecker *Dicaeum erythrorhynchos*	X	X	X	P, F, MF/pluck
F	Legge's flowerpecker*+ *Dicaeum vincens*	-	-	X	P, F, MF/pluck

Appendix II (contd.)

BIRD SPECIES OBSERVED AT THE HAKGALA SNR, HORTON PLAINS NP & PEAK WILDERNESS SANCTUARY AND THEIR HABITATS AND FEEDING ECOLOGY
(Common names as provided by author - Ed.)

Feeding guild & habitat	Family Common name Scientific name	HSNR	HPNP	PWS	Habit/ Feeding Strategy
	Cuculidae				
F	Koel *Eudynamys scolopacea*	-	-	X	S/pluck
F	Red-faced malkoha*+ *Phaenicophaeus pyrrhocephalus*	-	-	X	S/pluck
	Capitonidae				
F	Brown-headed barbet *Megalaima zeylanica*	X	-	X	S, MF/pluck
F	Small barbet*+ *Megalaima rubricapilla*	-	-	X	S, MF/pluck
F	Yellow-fronted barbet* *Megalaima flavifrons*	-	-	X	S, MF/pluck
AFNGS	**Psittacidae**				
F	Layard's parakeet* *Psittacula calthorpae*	-	-	X	P, F, MF/pluck, gnaw
F	Rose-ringed parakeet *Psittacula krameri*	-	-	X	F/pluck, gnaw
F	Large parakeet *Psittacula eupatria*	-	-	X	F/pluck, gnaw
F	Blossom-headed parakeet *Psittacula cyanocephala*	-	-	X	F/pluck, gnaw
F	Sri Lanka lorikeet* *Loriculus beryllinus*	-	-	X	P, F, MF/pluck, gnaw
GS	**Columbidae**				
F/G/S	Spotted dove *Streptopelia chinensis*	X	X	X	P/pick
F/S	Bronze-winged pigeon *Chalcophaps indica*	-	X	X	S/pick
F/G	Blue-rock pigeon *Columba livia*	X	X	X	P, F/pick
	Ploceidae				
S/G	House sparrow *Passer domesticus*	X	-	X	P, F/pick

Appendix II (contd.)

BIRD SPECIES OBSERVED AT THE HAKGALA SNR, HORTON PLAINS NP & PEAK WILDERNESS SANCTUARY AND THEIR HABITATS AND FEEDING ECOLOGY
(Common names as provided by author - Ed.)

Feeding guild & habitat	Family Common name Scientific name	HSNR	HPNP	PWS	Habit/ Feeding Strategy
G	Spotted munia *Lonchura punctulata*	X	-	X	P, F/pick
G	White-backed munia *Lonchura striata*	-	-	X	P, F/pick
G	Hill munia*+ *Lonchura kelaarti*	X	-	-	P, F/pick
AFI	**Pycnonotidae**				
F/S	Red-vented bulbul *Pycnonotus cafer*	X	X	X	P/Pick, catch
F	Black-capped bulbul* *Pycnonotus melanicterus*	-	-	X	F, MF/Pick, catch
F/S	Yellow-eared bulbul*+ *Pycnonotus penicillatus*	X	X	X	P, F, MF Pick, catch
F	Black bulbul *Hypsipetes leucocephalus*	X	X	X	P, F, MF/ Pick, catch
F	Yellow-browed bulbul *Hypsipetes indicus*	X	-	X	F, MF/Pick, catch
	Bucerotidae				
F	Grey hornbill*+ *Ocyceros birostris*	-	-	X	S, P/Pick, pluck, catch
FGIFN	**Zosteropidae**				
F	Hill white-eye* *Zosterops ceylonensis*	X	X	X	F, MF/Pick, glean, suck
F/S	Small white-eye *Zosterops palpebrosus*	X	-	X	F, MF/Pick, glean, suck
	Irenidae				
F	Jerdon's chloropsis *Chloropsis cochinchinensis*	-	-	X	P, MF/Pick, glean, suck
F	Goldfronted chloropsis *Chloropsis aurifrons*	-	-	X	P/pick, glean, suck
	Oriolidae				
F	Black headed oriole *Oriolus xanthornus*	-	-	X	S/pick, glean, suck

Appendix II (contd.)

BIRD SPECIES OBSERVED AT THE HAKGALA SNR, HORTON PLAINS NP & PEAK WILDERNESS SANCTUARY AND THEIR HABITATS AND FEEDING ECOLOGY
(Common names as provided by author - Ed.)

Feeding guild & habitat	Family Common name Scientific name	HSNR	HPNP	PWS	Habit/ Feeding Strategy
F	**Sturnidae** Whiteheaded starling*+ *Sturnus senex*	-	-	X	P, MF/pick, glean, suck
F	**Campephagidae** Large cuckoo shrike *Coracina macei*	-	-	X	S/pick, glean, suck
ATO F/G/S	**Sturnidae** Common mynah *Acridotheres tristis*	X	X	X	P, F/pick, catch
F/S	**Corvidae** Jungle crow *Corvus macrorhynchos*	X	X	X	P, F/pick, catch
TO F/S	**Phasianidae** Jungle fowl*+ *Gallus lafayetti*	X	X	X	S, F/scratch, pick
F/S	**Turnicidae** Bustard quail *Turnix suscitator*	-	-	X	S/scratch, pick
F/S	**Muscicapidae** Common babbler *Turdoides affinis*	-	-	X	F/probe, pick
Total	37 families, 116 species (23 endemics)	61	47	98	

HSNR - Hakgala Strict Nature Reserve
HPNP - Horton Plains National Park
PWS = Peak Wilderness Sanctuary

Feeding guild: ABI - Arboreal Insectivore, AI - Aerial Insectivore, FGI - Foliage Gleaning Insectivore, BGI - Bark-Gleaning Insectivore, TI - Terrestrial Insectivore, GI - Grassland Insectivore, AC - Aerial Carnivore, ATC - Arboreal-Terrestrial Carnivore, WC - Wading Carnivore, AN - Arboreal Nectarivore, AF - Arboreal Frugivore, AFNGS - Arboreal Frugivore, Nectarivore, Granivore, Seed-eater, GS - Granivore, Seed-eater, AFI - Arboreal Frugivore, Insectivore, FGIFN - Foliage Gleaning Insectivore, Frugivore, Nectarivore, ATO - Arboreal-Terrestrial Omnivore, TO - Terrestrial Omnivore.

Habitats: F - Forest; S - Scrub; G - Grassland;
Aq - Aquatic habitats (streams/ponds/marshes)

Status: * endemic species, + nationally threatened species WM - winter migrants.

Habit: S - solitary, P - pairs, F - flocks, MF - mixed species flocks.

CROP DAMAGE BY BLACKBUCK *ANTILOPE CERVICAPRA* AT ROLLAPADU WILDLIFE SANCTUARY, ANDHRA PRADESH[1]

Ranjit Manakadan and Asad R. Rahmani[2]

(*With one text-figure*)

Keywords: Crop damage, blackbuck *Antilope cervicapra*, Rollapadu Wildlife Sanctuary, Kurnool district, Andhra Pradesh.

The paper discusses crop damage by blackbuck *Antilope cervicapra* at Rollapadu Wildlife Sanctuary (RWS), Andhra Pradesh, based on studies carried out during 1993-1994. Damage was recorded in 8 of the 20 crop species studied in the vicinity of the Sanctuary. Damage was high in foxtail millet, sorghum, and in the irrigated summer greengram and blackgram crops, moderate in redgram, groundnut and greengram (monsoon crop), low in cotton and minimal in sesamum. The extent of damage depended on many factors, which are discussed. Damage was negatively correlated to distance from the blackbuck area for five of the six species (except for cotton) studied. Except for sesamum, which is thrashed to the ground by male blackbuck, the other species are eaten. The damage recorded in cotton is likely to be due to livestock, and probably some of the damage recorded for the other crops could also have been contributed by livestock. Thus, it is advised that claims for crop damage compensation by farmers should be scrutinised carefully before approval. Measures to stop or reduce crop damage are suggested.

INTRODUCTION

The blackbuck *Antilope cervicapra* is a major component of the semi-arid grassland ecosystem of the plains of the Indian subcontinent. It is known to take to crop-raiding (Ranjitsinh 1989, Chauhan and Sawarkar 1989, Prakash 1990, Prasad and Ramana Rao 1990). In some areas, crop raiding by blackbuck is a recent problem due to the increase in blackbuck numbers after recent conservation steps for the animal and/or the habitat (Rahmani 1985, Schultz 1986, Chauhan and Sawarkar 1989, Chauhan and Singh 1990, Manakadan and Rahmani 1993, Chandra 1997). These crop depredations antagonise farmers, resulting in a negative attitude towards blackbuck conservation, and conservation of wildlife in general.

During a U.S. Fish and Wildlife Service sponsored study by the BNHS and the Centre for Wildlife and Ornithology, Aligarh Muslim University, on the ecology of the grasslands of RWS, we undertook a study on the crop damage by blackbuck to know which species were being affected, the nature of the damage, and to some extent, attempted to quantify the extent of the damage. Special efforts were made to check if the damage was by blackbuck, as we realised that some farmers were exaggerating or wrongly attributing livestock-caused crop damage to blackbuck. This was either due to ignorance, to get monetary compensation for crop damage, or to give a bad name to the Sanctuary so as to demand grazing rights within the protected enclosures or to get back the land lost by farmers and graziers when the Sanctuary was established.

It is hoped that the results and recommendations of this study will be used as a management strategy to decrease the problem of crop damage by blackbuck at Rollapadu and in other sanctuaries which have the same problem.

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STUDY AREA

Rollapadu is situated 18 km southeast of Nandikotkur (15°58' N & 78°18' E), Kurnool dist., Andhra Pradesh. It lies in the plains between the Nallamalai and Yerramalai hills, at an altitude of about 200 m. The terrain is gently undulating with predominantly poor red soils. The region is semi-arid with an average annual rainfall of 668 mm, received from both the Southwest and Northeast monsoons. Summer peaks at 42°C (April and May) and winters are mild (17°C).

Rollapadu (area: 6.14 km^2) had its origin in 1982, after the 'rediscovery' of the great Indian bustard *Ardeotis nigriceps,* and was declared a Sanctuary in 1988. The Sanctuary proper consists primarily of three grassland plots or enclosures: Enclosure-I: 320 ha, Enclosure-II: 40 ha and Enclosure-III: 120 ha (Fig. 1). These enclosures are demarcated by trench-cum-mound (TCM) walls to exclude livestock and people. However, Enclosure-III was opened to grazing after protests by the locals about the lack of sufficient grazing land for their livestock. The extent of protection to Enclosure-II varied from year to year. The three enclosures are separated from each other by grazing land and crop fields. The other major fauna of the Sanctuary include the lesser florican *Sypheotides indica*, harriers (largely *Circus pygargus* and *C. macrourus*), blackbuck *Antilope cervicapra*, wolf *Canis lupus*, jackal *Canis aureus*, Indian fox *Vulpes bengalensis* and common Indian monitor *Varanus bengalensis*. For more details of the Sanctuary, see Manakadan and Rahmani (1989, 1993 &1997).

BLACKBUCK

Population: The blackbuck is one of the many grassland species that has benefited from the conservation measures intended for the great Indian bustard. According to the locals, the area always harboured blackbuck, which were hunted by locals and outsiders. The population in 1985 was 17 individuals, which rose to around 35 by 1987, and was about 300 animals during the present study (Manakadan and Rahmani 1989, 1993, 1997).

Movements: The onset of the southwest monsoon in June/July heralds the movement of blackbuck into Enclosure-I, and this congregation is seen till about January. This is due to a combination of rich grazing grounds, lack of human and associated disturbances inside the enclosure, coupled with the overgrazed conditions in the surrounding grazing land and heavy disturbance there. However, blackbuck move into crop fields late in the evening and return to the enclosure early in the morning. By the middle of January, the grasslands dry up, the harvest in the surrounding crop fields is almost over and most of the livestock (especially sheep) migrate to other areas. The blackbuck then disperse over a wide area, moving into the surrounding grazing land and harvested or fallow fields. Thus the density of blackbuck is low in the enclosure from February till the onset of the monsoon.

While in the grazing land, the blackbuck mainly frequent areas to the east and northeast of Enclosure-I and to a lesser extent south-west of Enclosure-III (Fig. 1). This is due to the presence of extensive grazing land and less human and associated disturbances in these areas compared to other parts of the grazing land. In general, blackbuck tend to avoid areas in the vicinity of villages, intensive agriculture zones and where there is a regular movement of humans or vehicles.

CROPS AND CROPPING PATTERN

The sowing of redgram, groundnut, foxtail millet, sesamum, greengram, blackgram, cowpea, Deccan hemp, cotton and paddy commences with the onset of the Southwest monsoon. The harvest depends on the duration of the crop (Table 1). Sorghum and Bengal gram are sown in October/November, the latter is generally sown in harvested and re-ploughed

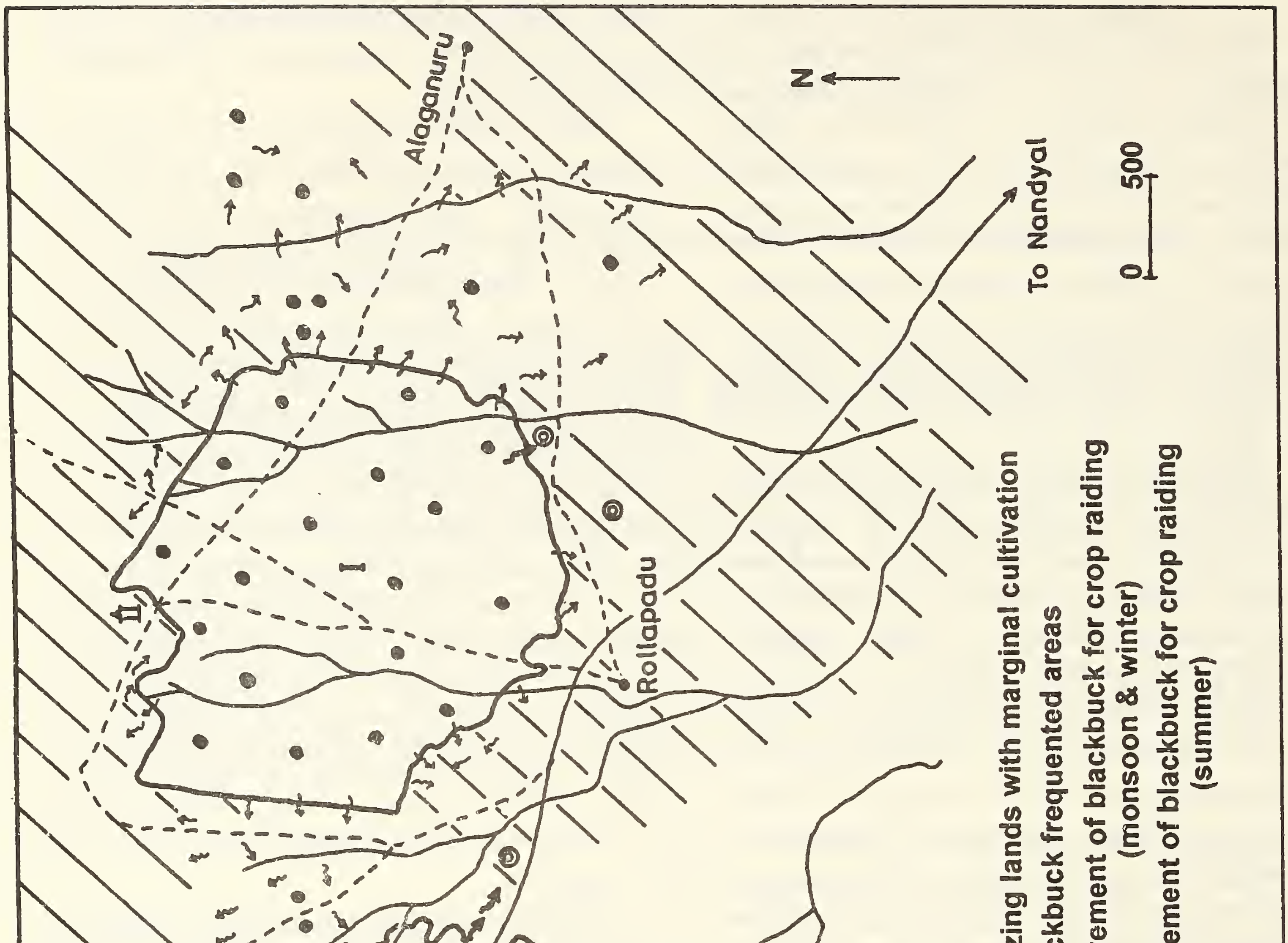
Alaganuru
N
To Nandyal
0 500
Rollapadu
I
II
III
To Jalakanuru
To Cherkucherla
To Nandikotkur
LEGEND
I,II,III Enclosures
Temple
Stream
Percolation tank
Well
Intensive Agriculture
Cart tracks
Grazing lands with marginal cultivation
Blackbuck frequented areas
Movement of blackbuck for crop raiding (monsoon & winter)
Movement of blackbuck for crop raiding (summer)

Fig. 1: Map of Rollapadu Wildlife Sanctuary showing distribution and movement of blackbuck into crop fields

TABLE 1
CROPS AND CROPPING PATTERN AROUND ROLLAPADU WILDLIFE SANCTUARY

	Crop	Scientific Name	Approximate Acreage (Percentage of all crops)	Sowing Period	Harvest Period
1.	Sorghum	*Sorghum bicolor*	20%	Oct.	Jan./Feb.
*2.	Groundnut	*Arachis hypogea*	20%	Jun./Jul.	Nov.
3.	Cotton	*Gossypium arboreum*	20%	"	Mar.
*4.	Redgram	*Cajanus indicus*	10%	Jun./Jul.	Jan.
5.	Sesamum	*Sesamum indicum*	10%	"	Dec.
6.	Sunflower	*Helianthus annus*	5%	"	Nov./Dec.
7.	Foxtail Millet	*Setaria italica*	5%	Jun./Jul.	Oct.
8.	Paddy	*Oryza sativa*	-	"	Dec.
9.	Bengal gram	*Cicer arietinum*	-	Nov.	Jan.
**10.	Greengram	*Vigna radiata*	-	"	Dec.
**11.	Blackgram	*Vigna mungo*	-	"	Dec.
**12.	Cowpea	*Vigna sinensis*	-	"	Dec.
13.	Deccan Hemp	*Hibiscus cannabinus*	-	"	Dec.
14.	Mustard	*Brassica campestris*	-	"	Mar.
15.	Cucumber	*Cucumis sativus*	-	Jun./Jul.	Nov/
16.	"	*Cucumis sp.*	-	"	"
#17.	Chillies	*Capsicum spp.*	-	"	Apr.
#18.	Brinjal	*Solanum melanoxylon*	-	"	"
#19.	Tomato	*Lycopersicon esculentum*	-	"	"
20.	Mulberry	*Morus alba*	-	(perennial)	

* Grown in winter also if irrigation is available. ** Grown in summer also if irrigation is available

# Generally irrigated by wells. (-) Forming rest of the 10%.

paddy fields. Where irrigation from wells is available, a second crop of groundnut may be sown in November, along with some short duration grams. However, irrigation is mainly intended for growing vegetables like brinjal, tomato and chillies. Most of the fields are bare after February and most of the wells dry up by April, hence there are hardly any crop fields from April till the onset of the monsoon in June/July.

Sorghum, foxtail millet, Bengal gram, sunflower, groundnut, cotton and paddy are grown in pure stands. Redgram, sesamum, greengram, blackgram, cowpea, cucumber and Deccan hemp are generally grown in rows in the fields of cotton and groundnut. Sorghum may also be sown in the fields of groundnut after the harvest, and thus would be growing in between the rows of the existing redgram.

The soil characteristics and soil depth determine the intensity of cultivation, viz., intensive, marginal or isolated fields (see Fig. 1). During the crop season, there is a regular stream of workers into crop fields — for weeding, tilling, applying fertiliser or pesticide, and harvesting of early crops. Due to this, intensively cultivated patches would have more human disturbance (for blackbuck) than marginal or isolated crop fields.

In Table 1, the crop and cropping pattern around RWS are given. Only the approximate percentage acreages of the crop species (according to our estimates) are given, as the information obtained from the local records was found to be incorrect when checked in the field. It was not possible to map the crop fields as the area was large, the work would be time consuming, and was further hampered by the mixed cropping in many fields and crop rotation within a growing season.

METHODOLOGY

Estimation of crop damage by wildlife is difficult to quantify, may involve measures of numerous variables and different methods of sampling, and the estimation can be based on parts of the plant, whole plants, or whole plots (Mower *et. al.* 1997). Crop damage estimation at RWS was more problematic as we were dealing with as many as 20 crop species, many with different growing seasons. We defined damage as the percentage of damage recorded in the samplings, based either on the number of quadrats laid or number of plants assessed for damage. The extent of damage to each plant or parts of the plant was not quantified, instead we qualitatively recorded which part of the plant was affected. The methodology adopted for our study was as follows:

In each sampling, we recorded the number of plants in the field or quadrat, numbers damaged, parts damaged and the height and stage of the crop. The sampling was in a straight line, radiating at many points away from Enclosure-I, and stopping after a few quadrats when damage was not being recorded. During subsequent visits to the fields at different stages of the crops, new areas of the fields were sampled, and not where damage had been recorded during earlier sampling (earlier damaged plants could generally be recognised by their pruned appearance and shorter heights). Three types of sampling methods were adopted due to the varying acreages of the different crop species.

1. In crop species where the number of fields were abundant, sampling by quadrats (1 m^2) was adopted, and damage was assessed for the total number of quadrats laid out, the number of quadrats in which damage occurred and the number of plants damaged in these quadrats.

2. For species where only a few plants were present (e.g. sesamum, Deccan hemp, greengram) in a field (as in the case of mixed cropping), quadrats were not used. Instead, all the plants or a fixed number in the crop field were assessed for damage.

3. When there were only a few fields of a crop species, then all the available fields (and the plants in the field) were checked for damage.

Thus the sample sizes for the different crops were as follows:

Quadrats: Groundnut - 96: 2267; Redgram - 205: 2515; Foxtail millet - 75: 5093; Cotton - 106: 1557; and Sorghum - 159: 1694 (0-30 cm height); 192: 2256 (31-75 cm height) and 273: 3040 (>76 cm height). *(Note: The values indicate the number of quadrats laid and the total number of plants assessed for damage).*

Plants: Where all the plants in a field or a fixed number were assessed for damage: Sesamum - 3313, Greengram - 210 (monsoon), 627 (summer); and Blackgram - 40 (monsoon), 446 (summer). *(Note: The values indicate the number of plants sampled).*

Fields: Where all the available fields (and all the plants in the fields) were checked for damage: Paddy - 7; Bengal gram - 2; Mulberry -1; Mustard - 1; Cucumber spp. - 3; Sunflower - 14; Deccan hemp - 9; Cowpea - 3; Chillies - 1; Brinjal - 1; Tomato - 1 *(Note: The values indicate the number of fields sampled).*

Distances of the fields from the blackbuck area were noted. Preventive measures taken to control crop damage were recorded either from observations or enquiries from farmers. Presence of blackbuck and livestock in crop fields, either from sightings or signs (hoof prints and faeces) were noted to know if the damage was by blackbuck or livestock. The data presented is based on one cropping season: 1993-1994.

Data Analysis: Except for jowar, where

TABLE 2
DETAILS OF CROP DAMAGE AROUND ROLLAPADU WILDLIFE SANCTUARY

Crop	Parts Damaged	Stage of Crop	Remarks
Damaged			
Sorghum	shoot & leaves	GS	
Foxtail Millet	shoot, leaves & fruit	GS, FF	
Groundnut	shoot & leaves	GS	
Redgram	shoot	SS	
Greengram	shoot & fruits	FF	
Blackgram	shoot & fruits	FF	Few samples.
Sesamum	whole plant	FF	Thrashed to the ground by male blackbuck
Cotton	shoot	GS	Damage by livestock?

SS = Seedling Stage GS = Growing Stage FF = Flowering & Fruiting Stages

Not damaged: Deccan Hemp, Bengalgram, Cowpea, Paddy, Mustard, Cucumber (two species), Mulberry, Sunflower, Chillies, Brinjal, Tomato.

analysis was done for different height classes, the other species were not broken into different stage or height classes for damage assessment. This was because the other species had already passed the seedling stage when the studies started. Further, the growing stages of these species were not clearly defined and extended, as in sorghum. However, general notes on these species, to see at what stages the damage occurred, were taken and are used non-quantitatively in Table 2.

For correlation analysis of the extent of damage with distance from the blackbuck frequented area, only the fields where there were no barriers (such as deep TCM walls, intervening dense natural vegetation, buffers of other extensive stands of preferred/non-preferred crop species) and where crop protection measures were not adopted, were used for analysis. Greengram, blackgram and sesamum were not included, as the first two species usually have buffers of taller crops around them. In the case of sesamum, it is not eaten, but thrashed down by male blackbuck. Hence, the distance to damage correlation was attempted only for groundnut, redgram, foxtail millet, sorghum and cotton.

RESULTS

Of the 20 crops studied, damage was recorded in 8 species, namely sorghum, foxtail millet, jowar, groundnut, sesamum, greengram, blackgram and cotton (Table 2). Of these, it is doubtful whether the damage recorded in cotton was caused by blackbuck. Though damage was not recorded in two members of Cucurbitaceae, seedlings of one (or both?) of these plants were recorded growing in blackbuck middens. Of the 8 species of crops, 7 were used as food. Sesamum was damaged by male blackbuck thrashing plants to the ground with their horns.

The stage of the crop and parts eaten/damaged differed according to the species (Table 2). Damage was high in foxtail millet and sorghum, irrigated summer crops of greengram and blackgram, moderate in redgram, groundnut and monsoon crop of greengram, low in cotton and very low in sesamum (Table 3). Frequency of damage (quadrat-wise damage) showed higher values than intensity of damage (plant-wise damage) for all crops, indicating that the damage is spread out over the fields. A good proportion of damage recorded in redgram was possibly due to cattle, as many cases of damage were recorded in freshly tilled fields. In sorghum, the only crop species for which damage was quantified on a temporal scale, damage was lowest when the crop was in the range of 31-75 cm tall. Locals say sorghum becomes toxic during this stage and livestock feeding on it become sick or even die.

Though the paddy, sunflower and mulberry fields adjoined the enclosure and the blackbuck were not hindered by any barriers to visit these crops, damage was not recorded. This shows that blackbuck certainly do not eat these crop species. The same cannot be said for the other crop species where damage was also not recorded (i.e., Deccan hemp, Bengal gram, cowpea, mustard, chillies, brinjal and tomato), as there were few fields of these crops and the fields were in areas not very accessible to blackbuck. Hence, the unpalatability of these crop species to blackbuck cannot be completely ruled out.

The intensity of damage in sorghum, foxtail millet, groundnut and redgram was reduced gradually as the distances from Enclosure-I increased (negative correlation: Pearson's r= 0.434, P=0.001 for all species combined). For cotton, there was a positive correlation for the same (r=0.329, P=0.054), i.e., further the distance, the more the damage. This again suggests that the damage to cotton was caused by livestock, and not blackbuck.

Discussion

Many factors influence the nature and extent of crop damage by blackbuck in a particular area. One of the most obvious would be the population size of blackbuck. Complaints of crop damage hardly occurred earlier when the blackbuck population at RWS was 17 animals in 1985 and 35 in 1987. In addition to blackbuck densities, the distance of the crop fields from the blackbuck area also determines the extent of damage, i.e., the more the distance of the crop fields from the blackbuck frequented areas, the less would be the damage. In general, damage was recorded within 200 m of the northern and southern borders of Enclosure-I, (intensive cropping areas) and one kilometre off the eastern and western borders (marginal cropping areas, interspersed with grazing lands). Blackbuck stray less into intensive crop areas due to the dense crop cover, relatively higher presence of humans, and absence of safe open areas to wander or retreat into, unlike in marginal cultivation. Crop fields that are close to the enclosure, or those situated near areas in grazing land frequented by blackbuck are more prone to crop damage.

Table 3

EXTENT AND DISTRIBUTION OF CROP DAMAGE

Species	Quadrat-wise	Plant-wise
	(For sample sizes, see text)	
Groundnut	20.0	9.6
Redgram	27.8	12.0
Greengram		
(monsoon crop)	-	14.3
(summer crop)	-	79.9
Blackgram		
(monsoon crop)	-	0.0
(summer crop)	-	50.0
Foxtail Millet	48.0	18.0
Sorghum		
(0-30 cm ht)	34.5	20.0
(31-75 cm ht)	19.2	9.9
(>76 cm ht)	20.0	14.4
Sesamum	-	0.6
Cotton	7.5	3.6

Note: - = Not done: plants too few and/or scattered.

Quadrat-wise: Indicates frequency of damage
Plant-wise : Indicates intensity of damage

The availability of a crop would also determine the extent of crop damage. Highly preferred species grown on a small scale would record greater damage than if the crop was grown on a large scale. The availability of the preferred crop also plays a role in determining the damage to less preferred species, especially if grown in close proximity to each other. This fact has applications in agriculture, where decoy crops are grown to prevent or reduce damage to the intended crop. This may explain why damage was not recorded in species like Bengal gram, paddy, til and mustard at Rollapadu, which are reported to be eaten by blackbuck in other areas (Ranjitsinh 1989, Prasad and Ramana Rao 1990, Chandra 1997). Or it could be that the findings obtained by them were erroneous as they were largely based on enquiries from farmers.

The factors influencing crop damage mentioned above could be offset by factors like barriers, crop protection measures and the presence of people. We found that broad and deep trench-cum-mound walls, checkdams and dense vegetation acted as barriers to blackbuck movement. Though the blackbuck is known to jump long distances, it was observed at RWS that they do not jump across broad and deep TCM walls, especially those that are buffered by dense and tall vegetation. Tall non-palatable or non-preferred crops also serve as barriers, especially for smaller preferred crops. For example, greengram and blackgram when grown scattered in fields of redgram or sesamum were not damaged, while exposed pure stands were heavily or even totally damaged.

Many of the cases of crop damage recorded could be partially or totally due to livestock, rather than by blackbuck. Much of the damage occurs due to straying of livestock into crop fields, as many crop fields adjoin grazing land. In fields that are tilled, damage by draught bulls is likely if they are unmuzzled, or if the muzzles are defective. Damage may also occur when the bullocks graze in the adjoining fallow fields or grazing land during rest and then stray into the crop fields. In many cases, we were sure that the damage was by livestock, from actual sightings; by the presence of their hoof marks in crop fields; and in case of cow and buffalo damage, by the nature of the damage. Humans too may be responsible for some of the loss recorded. For example, in the case of greengram grown in mixed fields, workers may pull off some unripe pods to eat and the blame may be attributed to blackbuck by the farmers.

Adoption of crop protection measures at RWS is rare and of recent occurrence. In general, it was seen (i) in the crop fields of rich farmers (by employing watchmen); (ii) in small family holdings where the stakes are high (especially where well-irrigation is done); (iii) in good soil areas (yields would be more and assured than in poor soils); and, (iv) in areas close to villages (proximity and safety). In most other cases, except for scarecrows, fields were largely left unguarded.

CONCLUSION AND RECOMMENDATIONS

The findings show that crop damage by blackbuck at Rollapadu Wildlife Sanctuary is of a serious nature and could worsen if measures to combat this problem are not taken immediately. Complaints from farmers are frequent. Their ire has also been redirected to the great Indian bustard (for which the Sanctuary was established) and the Sanctuary in general. After the problem of crop damage started, villagers talk of not wanting the Sanctuary, till recently a matter of pride for them. The Forest Department has still not taken measures to tackle the problem.

It is also evident from the study that some of the crop damage blamed on blackbuck (wantonly or due to ignorance) was actually caused by livestock. Some crop species are most likely not eaten at all by blackbuck (e.g. cotton). Thus, the Forest Department official in charge of RWS (and other such sanctuaries which have crop damage problems by blackbuck) should have an idea of crops that are palatable or non-palatable to blackbuck, should make actual visits to the crop fields to look for livestock signs in damaged fields, before attending to claims for crop damage compensation.

Based on the studies the following recommendations are given:

1. A crop damage compensation scheme should be started without delay. This would, to some extent, help to temporarily alleviate the grievances of the farmers.

2. Restricting the population of blackbuck to about 100 animals — either by culling or translocation. It is likely that with a population of 100 animals, the extent of crop damage would be small, judging from the past and present blackbuck populations and the history of crop damage at RWS. The topic of culling is of course a sensitive issue, and will be a major policy decision, needing the approval of the Ministry of Environment and Forests and changes in the Wildlife (Protection) Act. Interestingly, culling of blackbuck to reduce crop damage was practised earlier in India. The Raja of Wankaner has fixed a quota of blackbuck that had to be culled to prevent excess damage to crops in his region (Ranjitsinh 1982).

3. Fencing or hedging with *Gliricidia maculata* at the southern and northern borders of Enclosure-I. *Gliricidia maculata* is recommended since (i) it was found to be very successful in plantations at Nannaj, Solapur dist. Maharashtra, which has similar soil and climatic conditions; (ii) it would benefit farmers as it is a legume and its leaves are reported to be used as manure in some southern states of India. The fence or hedge would act as a barrier for blackbuck entering crop fields in these areas. Additionally, or as an alternative, broadening and deepening of the existing TCM walls could be done in these two regions. These two zones are intense agricultural areas, and the essential movement of blackbuck in summer out of Enclosure-I is mainly through and beyond areas in the eastern and western parts of Enclosure-I. These steps would minimise crop damage in fields to the north and south of Enclosure-I. For the marginally cultivated eastern and western areas, *Gliricidia* saplings may be given to farmers to be planted around individual fields.

4. The following are the changes suggested in cropping pattern to reduce crop damage:

a) Preferred species should be grown as far away from the enclosures as possible.

b) Non-palatable species, such as cotton, mulberry, paddy (where irrigation facilities are available) should be grown closer to the enclosures. Additionally, tall non-palatable species such as sesamum and sunflower could be grown closer to enclosures to serve as physical barriers to prevent access of blackbuck to preferred/palatable species grown further away.

c) Short and preferred crops like greengram and blackgram should be grown either in mixed fields of redgram or sesamum, or surrounded by a dense hedge of these two species.

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FOOD HABITS OF WILD UNGULATES AND THEIR COMPETITION WITH LIVESTOCK IN PENCH WILDLIFE RESERVE, CENTRAL INDIA[1]

Rakesh Shukla[2] and P.K. Khare[3]

Key words: Wild ungulates, livestock, overlap, competition

Food habits of a few wild ungulate species and the competing domestic ungulates are discussed. The selected species are chital (*Axis axis*), sambar (*Cervus unicolor*), nilgai (*Boselaphus tragocamelus*) and gaur (*Bos gaurus*). Grazing by livestock is allowed at the study sites I and II, and there is overlap of the two classes of ungulates in their food habits. This may lead to the degradation of wildlife habitat as the livestock outnumber the wild ungulates considerably.

INTRODUCTION

Increasing competition for food between livestock and wild ungulates in managed forests and wildlife reserves is a serious threat to effective wildlife management in India. Due to gradual shrinkage in wildlife habitats and their increase in numbers, domestic livestock compete with wild ungulates by encroaching upon the habitats previously utilized by wild ungulates only. When this occurs in a wildlife reserve, managed exclusively for wild animal populations, it leads to over-exploitation of wildlife habitats.

Comparative studies of the food habits of wild and domestic ungulates have been carried out in different habitats by a number of workers to assess the impact of competition (Mackie 1970, Berwick 1974, Dusek 1975, Dinerstein 1979). This paper deals with the seasonal food habits of common wild ungulates and their competition with domestic cattle in central Madhya Pradesh.

STUDY AREA AND METHODS

The study area, comprising three adjoining areas of different conservation status, the Rukhar Reserved Forest, the Pench Wildlife Sanctuary and the Pench National Park, is situated in Seoni dist., Madhya Pradesh. The study sites were designated site I (15.8 km^2), site II (10.5 km^2) and site III (12.7 km^2). Grazing by livestock was allowed at site I, regulated at site II, and banned at site III.

According to Champion and Seth (1968), the forests of Pench area are of 3 types:

3B/C1c. South Indian Moist Deciduous Slightly Moist Teak forests.

5A/C1b (IV). Southern Tropical Dry Deciduous Teak forests

5A/C3. Southern Dry Mixed Deciduous forests

However, we identified only two forest types, i.e. teak deciduous and miscellaneous deciduous.

Food habits of the wild and domestic ungulates were observed. The multicolumn check sheet (Duggan 1978) for data collection included the broad categorisation of the vegetation and food types. After observing the feeding ungulates through binoculars (10 x 50), on-site inspections of the food plants were made to identify the plant species. A herbarium of the unidentifiable species was prepared for later identification by botanists. On the basis of the frequency of specific plants being eaten by both classes of ungulates, they were categorized into high, medium and low preference. The study was conducted between 1987-1989.

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Results and Discussion

Food preference categories of wild and domestic ungulates are presented in Table 1. The chital was a grazer under better forage conditions. Dinerstein (1979) opined that chital was a willing browser utilising a wide variety of tree and shrub species, but the bulk of its diet was composed of grasses and sedges. Schaller (1967) also found chital to be a grazer. As the annual grasses attained maturity and turned coarse, and the forage conditions became poor in the study area, the chital switched over to selective and consistent browsing. The most preferred food plants for chital during the rains were grass species, *Heteropogon contortus, Dichanthium annulatum, Bothriochloa odorata, Iseilema laxum* and *Themeda quadrivalvis.* Among the preferred forbs were *Alysicarpus bupleurifolius, Asparagus racemosus* and *Crotalaria medicaginea.* When the forage conditions worsened during the late winter and summer, the bulk of the diet consisted of *Themeda quadrivalvis, Bothriochloa odorata, Imperata cylindrica* and *Eragrostis uniloides.* Leaves and flowers of *Madhuca indica, Syzygium cumini, Bridelia retusa, Bauhinia racemosa, Diospyros melanoxylon, Emblica officinalis, Flemingia semialata* and shoots of *Elephantopus scaber* and *Urena lobata* were also fed upon by the chital. Schaller (1967) observed that due to the diminished food value of the grass species, they were utilized prior to the end of the rains.

Sambar also fed on green grasses in favourable habitat conditions. Schaller (1967) recorded that they preferred grasses and sedges from June through October. Unlike in mature sal forest associations (Dinerstein 1979) when the habitat conditions in the study area restricted the preferred forage, sambar fed on a wider variety of plants (Table 1). Forsyth (1889) mentioned that during unfavourable forage conditions, it fed on a variety of leaves, pods, flowers and fruit. Sambar were frequently observed feeding on aquatic plants in shoulder-high water in the Dudhia tank at site I.

The gaur grazed and browsed on a much wider variety of plants than any other ungulate species in the study area. It fed on green grasses, young leaves and soft shoots during favourable forage conditions. Owing to its large body size, a single food item is not likely to form a large proportion of its daily intake. The gaur hardly differentiated between the low and high quality food during the pinch period in the hottest month, as it also fed on coarse grasses and the bark of young *Tectona grandis* trees. In general, the gaur appeared to be the least selective feeder.

The nilgai in the study area were also grazer/browser. They raided the agricultural crops around the study area during the late evenings or nights. Food habits of the nilgai were considerably different from those of the chital and sambar. Dinerstein (1979) mentioned that apart from a shared attraction to agricultural crops, nilgai and chital differ considerably in their feeding habits. During the rains and the early winter, when forage conditions were favourable, the nilgai also fed on a variety of browse plants. Being larger in size, more browse was easily accessible to the nilgai and it frequently browsed on trees such as *Bauhinia racemosa, Bauhinia vahlii, Zizyphus mauritiana, Zizyphus xylopyra* and *Randia dumetorum* (Table 1).

Domestic ungulates, regarded primarily as grazers (Berwick 1974), also browsed on several plant species in the study area (Table 1) during the hot season. Grasses and sedges were mainly eaten during favourable forage conditions. With grasses turning coarse and dry, livestock shifted to browsing to some extent until the onset of the monsoon. The livestock of many villages on the periphery of the study sites I and II, which have a good wildlife potential, outnumber the wild ungulates considerably. This overlap of two classes of ungulates in food habits may result in serious competition, leading to the degradation of otherwise fine wildlife habitats.

TABLE 1
USAGE OF PLANT SPECIES BY WILD AND DOMESTIC UNGULATES IN DIFFERENT SEASONS IN PENCH WILDLIFE RESERVES

Plant species	Part eaten	Preference					Season
		Chital	Sambar	Gaur	Nilgai	Livestock	
Grasses/Sedges							
Bothriochloa odorata	S	★★	★★	★★	★	★★★	RWS
Cynodon dactylon	S	★★★	★★★	★★★	★★★	★★★	RWS
Dichanthium annulatum	S	★★★	★★★	★★★	★★★	★★★	RWS
Eragrostis uniloides	S	★★	★★	★★★	★★	★★★	RWS
E. viscosa	S	★	★	★★	-	-	R
Heteropogon contortus	S	★★★	★★★	★★★	★★★	★★★	R
Imperata cylindrica	S	★	★	★★	★	★★	RWS
Iseilema laxum	S	★★	★★	★★	★	★	RW
Panicum montanum	S	★	★	★★	★	★	RWS
Saccharum spontaneum	S	★★	★★★	★★★	★★	★	RW
Setaria glauca	S	★	★	★★	★	-	RW
S. tomentosa	S	★	-	★★	★	★★	RW
Sporobolus diander	S	-	★	★	-	-	RW
Themeda triandra	S	★★★	★★★	★★★	★★★	★★★	RWS
T. quadrivalvis	S	★★	★★★	★★★	★	★★	RWS
Cyperus rotundus	S	★	★	-	-	★	RW
Forbs							
Alysicarpus bupleurifolius	S	★★	-	-	-	-	R
Asparagus racemosus	L	★★	-	-	-	-	R
Cassia pumila	S	★	★	★★	-	★	RW
Crotalaria medicaginea	L	★	★	★★	★	-	R
Celosia argentea	L	★	★	★★	-	-	RW
Desmodium triflorum	L	-	-	★★	-	-	RW
Elephantopus scaber	L	★★	★★	★	-	-	RW
Phoenix acaulis	L	★	★	★★	★	-	RWS
Smilax prolifera	L	★	★	-	★	★	RW
Sida rhombifolia	L	★	-	★	★	★	W
Urena lobata	L	-	-	-	★★	-	W
Seedling/Saplings							
Adina cordifolia	B^1,L,F	★	-	★	★	-	WS
Aegle marmelos	L	★★	★	-	★★	★★	RW
Buchanania lanzen	F	★	-	★	★	★	S
Bridelia retusa	L	★	-	-	-	-	RW
Bauhinia racemosa	L,F	★	-	-	★★	★	WS
B. vahlii	L,F	★★	★★	★★	★	★★	WS
Cassia fistula	L	★	-	★	★	-	WS
Cordia myxa	L	★	★	★★	★	-	S
Careya arborea	F	★	★	★★	★★	-	R
Dioscorea bulbifera	L	★★	★	-	★	-	RW
Dendrocalamus strictus	L	★★	★★	★★★	★★	★★	RWS
Diospyros melanoxylon	L,F	★	★	★★	★	-	WS
Emblica officinalis	L,F	★	★	-	★	-	RW
Flemingia semialata	L	★	★★	★★★	★	★★	RWS
F. bracteata	L	★★	★★	★★★	★★	★	RWS
Ficus bengalensis	F	★★	★	★★	★	★	S
F. glomerata	F	★	-	★	★	★	S

(CONTD.)

TABLE 1 (CONTD.)

USAGE OF PLANT SPECIES BY WILD AND DOMESTIC UNGULATES IN DIFFERENT SEASONS IN PENCH WILDLIFE RESERVES

Plant species	Part eaten	Preference					Season
		Chital	Sambar	Gaur	Nilgai	Livestock	
Kydia calycina	S	★	★	★★	★★	-	WR
Lagerstroemia parviflora	L	★	-	★★	★	-	WS
Madhuca indica	L,F	★★★	★	★★★	★	★	WS
Mitragyna parvifolia	L	★★	★	-	★	-	R
Randia dumetorum	L,F	★	-	★	★	-	RW
Semecarpus anacardium	F	★	-	★	-	-	W
Syzygium cumini	L,F	★	★★	★★★	-	★	WS
Tectona grandis	B[1]	-	-	★	-	-	S
Terminalia tomentosa	L	★	-	★	★	-	RW
T. bellerica	L	★	★	-	★	-	W
Zizyphus rotundifolia	L,F	★★★	★★	★★★	★★	-	WS
Z. mauritiana	L,F	★★	★	★★	★★	-	W
Z. xylopyra	L,F	★★	★	★	★★	-	S

1= Eaten by the gaur only

Seasons: R = Rains W = Winter S= Summer

Preference: ★ = Low ★★ = Medium ★★★ = High

Parts eaten: S = Shoots L = Leaves F = Fruit B = Bark

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TEMPORARY GROUP SPLITTING IN THE LION-TAILED MACAQUE *MACACA SILENUS* IN A FOREST FRAGMENT IN INDIRA GANDHI WILDLIFE SANCTUARY, TAMIL NADU[1]

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Key words: Lion-tailed macaque, Indira Gandhi WLS, Tamil Nadu, subgrouping

This paper examines the incidence of temporary group splitting in the lion-tailed macaque, in a small rain forest fragment in the Indira Gandhi Wildlife Sanctuary. The fragment (65 ha) was highly degraded and was privately owned. The study was conducted from January to March 1995, when 315 hours of observations were made, primarily through group scan sampling of a group of 34 animals. The group spent about 42.22% of their time as subgroups, which was significantly more likely to occur when the group was ranging (64.2%) than while foraging (26%) or feeding (41.3%). Subgrouping was less likely in areas with low canopy cover and was considerably greater in the fragments compared to continuous forest (3%, Kumar 1987). It is likely that this increased subgrouping reflects altered distribution of food plants and predation pressure.

Introduction

The lion-tailed macaque (*Macaca silenus*), one of the most endangered primates, is endemic to the tropical wet evergreen forest of the Western Ghats in South India (Green and Minkowski 1977, Kurup 1978, Kumar 1985). A large proportion of its total population occurs in forest fragments ranging in size from less than 10 ha to 20 sq. km, with only about 30% of the population in forests larger than 100 sq. km in area (Kumar 1995). In many places in its distribution range, small populations of the lion-tailed macaque, consisting of one or two groups, are confined to small forest fragments. Such fragments are often surrounded by tea estates and human settlements that are barriers to dispersal. Due to this, groups in forest fragments are often larger than in continuous forests.

In forest fragments, the groups are unable to expand the home range as the group size increases, as happens in continuous forests (Kumar 1987). The resulting increase in competition for food is further enhanced by habitat degradation that the forest fragments are often subjected to due to logging, fuel wood collection, and cardamom and coffee cultivation. In this situation, the only option is to reduce the group size, through temporary or permanent fission of groups. When forest fragments are small, permanent fission is not feasible because smaller home ranges are probably not to the benefit of both the groups. On the other hand, opportunistic temporary group fission allows reduced food competition when the food sources are patchy, while fusion benefits the individuals of a larger group in gaining protection from predators, when the food sources are large enough.

This short study on the lion-tailed macaque examines the incidence of group splitting in a forest fragment in relation to that reported from a continuous forest (Kumar 1987), and identifies associated activities and habitat features.

Study area

The study was conducted in Puthuthottam Estate, a privately owned cardamom estate, about

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1.5 km from Valparai town, on the Pollachi-Valparai Road. Geographically, it falls within the Indira Gandhi Wildlife Sanctuary (1000 sq. km), but administratively it is not a part of the Sanctuary. This forest fragment is situated at an altitude of 1085 m, at 10° 20' N and 96° 58'E. The average annual rainfall in the area is about 2735 mm (Menon 1993). The estate is 65 ha in area, and is surrounded by tea and coffee plantations and a road with heavy traffic passes through it.

This patch was formed in 1906 when the surrounding wet evergreen forest was cleared for tea plantation. Later, the undergrowth was cleared for cardamom and coffee plantation. Most of the emergent trees were felled for shade management. In subsequent years, there has been selective logging of trees, the last occasion in 1992. Lion-tailed macaques have been present here for many years (Kumar 1987). The first study on them was by Menon (1993) who examined ecological changes in lion-tailed macaque in forest fragments. Kumar *et al.* (1995) studied ecological and demographic changes for two years.

Other arboreal mammals in the forest fragment are the Malabar giant squirrel (*Ratufa indica*), large brown flying squirrel (*Petaurista petaurista*), and Travancore flying squirrel (*Petinomys fuscocapillus*). Many terrestrial larger mammals such as the tiger (*Panthera tigris*), leopard (*Panthera pardus*), elephant (*Elephas maximus*), gaur (*Bos gaurus*), sambar (*Cervus unicolor*), and barking deer (*Muntiacus muntjac*), often use the fragment as a day time refuge.

METHODOLOGY

The study was conducted from January to March 1995, and about 312 hours of observations were made, mostly from dawn to dusk. During the study period, the fragment had a single group of 34 animals, consisting of four adult males, 15 adult females and 15 juveniles. Time budget was estimated using group scan (Altman 1974) at 15 minute intervals. At each scan, the activities of all visible animals were recorded. These were feeding, foraging, ranging and other activities such as social interactions. Whether the group was together or in subgroups was recorded at two hour intervals, along with group size. The group was considered split whenever the group size was 27 or less, and no other members were found within 100 m. The activity in which most of the animals were engaged during a scan was considered the group activity for examining its association with group fission.

In order to test whether group fission was more likely to occur in some parts of the fragment than others, the study area was divided into five zones. First four zones were in the fragment, the fifth zone being an adjoining coffee plantation. Canopy contiguity was visually estimated at several points along transects in each zone. The location of the group with reference to these zones was also recorded at two hour intervals. For Chi-square test, records at two hour intervals were considered separate occurrences.

RESULTS

During the study period of three months, the group spent 33.03% of the daytime on foraging, 32.95% on ranging, and 21.93% on feeding. Considerably less time was spent on resting (4.6%) and other activities, such as social interactions (7.46%). Only 11.81% of the time was spent on plant foods, the rest (10.12%) being spent on animal foods. During the three months, the group fed on fruits and seeds from nine species (*Cullenia exarillata, Artocarpus heterophyllus, Macaranga peltata, Syzygium laetum, Maesopsis eminii, Maesa indica, Ficus benghalensis, Lantana camara*, and *Coffea arabica*). Leaf buds of *Macaranga peltata* were eaten on a few occasions. Animal food consisted mostly of invertebrates, primarily picked from among dry leaves, the other sources being green foliage and bark.

A total of 135 records were made at two hour intervals on the occurrence of subgrouping, and the associated major activity of the group. Subgrouping occurred 57 times, or in 42.22% of observations. Subgrouping occurred much more frequently when the group was ranging (64.1%) than while foraging (26%) and feeding (41.3%). A chi-square test (χ^2 = 13.01, df=2, p<0.05) showed that the observed incidence of subgrouping while the group was ranging (25 times) was much more than expected (16 times) if subgrouping had occurred randomly. In comparison, subgrouping occurred much less (13 times) than the expected (21 times) when foraging, and while feeding, observed was the same as expected (19 times). The group was thus more likely to form subgroups during ranging, and remain together while foraging.

The occurrence of subgrouping in the five zones varied from 33.33% to 55.00% but there was no significant difference among them (χ^2 = 1.53, df=4, p>0.05). However, the percentage occurrence of subgrouping increased with mean canopy (contiguity in the five zones (rs=0.9; n=5; P<0.05). Thus subgrouping was lowest (33.33%) in the coffee estate which had a very low canopy contiguity (<20%) and highest in zones I and II (46.66% and 55.00% respectively) which had the most contiguous forest in the fragment (64.9% and 69.2% respectively). Subgrouping was significantly more frequent in the forenoon (54.2%) than in the afternoon (32.9%) (χ^2 = 6.18 df=1, p<0.05)

DISCUSSION

Subgrouping occurred in the study group on all days studied. The frequency of subgrouping was also considerably high (42.22%). In contrast, in a group studied by Kumar (1987) in a continuous forest, the frequency of subgrouping was much less (3%). The higher incidence of subgrouping observed agrees with the prediction that as group size increases or food abundance decreases or both, a group should show greater incidence of subgrouping. It is interesting, however, that subgrouping while feeding occurred randomly. It was significantly higher while ranging and less while foraging. When the group was feeding on coffee pods in the coffee plantation, the group was often together. The uniform dispersion of the coffee pods over a wide area decreased food competition, while the larger group size probably gave the group protection against predation, especially by feral dogs. The feral dogs in the area are major predators on juveniles in the forest fragments. This also accounts for lesser subgrouping when canopy contiguity is low. Most of the feeding elsewhere in the fragments was on trees randomly distributed. Some of the trees, such as *Ficus benghalensis*, were rare but large enough to accommodate the entire group; some medium sized trees (such as most of the *Cullenia exarillata* trees) were common, hence the group fed on two or three separate trees at the same time, leading to subgrouping. Food was uniformly dispersed, highly clumped or patchily distributed, and subgrouping while feeding reflected this. Most of the foraging was in an area where the forest was most contiguous and least disturbed, and was mostly for insects, which were highly dispersed. Foraging was, therefore, unlikely to benefit from subgrouping.

That the group was more likely to form subgroups while ranging defies simple explanation. Subgrouping was often initiated when the group was moving away from major food sources such as a coffee plantation or large ficus trees. It was also noticed often that the subgroups united at major food sources, moving in from different directions. As a result, the entire group rarely moved together for any great length of time.

It is, however, worth noting that subgrouping in the fragment was considerably higher than in the continuous forest for all activities. This reflects drastic reduction in food abundance and change in the food distribution. With most of the emergent trees removed along with most of the understorey, shrubs and large lianas, there was drastic reduction not only in food abundance but also in the size of food sources and their distribution. This has affected the social organisation of the lion-tailed macaque.

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POPULATION, MOULT, BIOMETRICS AND SUBSPECIES OF LARGE SAND PLOVER *CHARADRIUS LESCHENAULTII* WINTERING IN SOUTHEAST INDIA[1]

S. Balachandran[2]

(*With two text-figures*)

Key words: *Charadrius leschenaultii crassirostris, Charadrius leschenaultii leschenaultii,* Australia, adult, first year bird, moult, weight, Gulf of Mannar.

Based on the results of the bird ringing studies conducted between 1985-1988, along with bird count data, this study provides information on the population, moult, proportion of young birds, measurements and subspecies of the large sand plover *Charadrius leschenaultii* wintering in the Gulf of Mannar Marine National Park in southeast India. About 300-500 birds winter and some individuals spend the breeding season (summer) here. The proportion of "first year" birds was < 30%. Adults complete the primary moult by October, one to two months earlier than in northwest Australia. Birds weighed at departure weigh at least 30% less than in Australia. Two subspecies, *crassirostris* and *leschenaultii*, have been recognised from the wintering population.

INTRODUCTION

This study presents the results of bird migration studies carried out between 1985-1988 at the Gulf of Mannar (GOM) Marine National Park, an important wader habitat in India. Although the large sand plover *Charadrius leschenaultii* is known to winter all along the seaboard of India, its distribution pattern is not clearly known. However, it is seen in small numbers on the entire seacoast of India (Ali and Ripley 1983). Moreover, bird ringing carried out at different sites along the east coast from Orissa (Chilka Lake) to south Tamil Nadu indicates that it is seen in several hundreds only in GOM, which has extensive intertidal sandflats, the most favoured habitat of this species.

An eastern species, the large sand plover occurs in greater numbers towards east Asia, and in Australia where it is one of the four abundant wintering species (Barter and Barter 1986). This paper deals with the population fluctuation, proportion of young birds, moult and measurements, and subspecies recognition, based on the bird count and ringing data for 160 individuals ringed in three migratory seasons between 1985-1988. The weight and moult score recorded during this study is compared with the observation made at northwestern Australia by Barter and Barter (1986).

STUDY AREA

Two corals islands, namely Manali and Hare Island and Pillaimadam lagoon in the GOM near Mandapam, and the Dhanushkodi lagoon in Rameswaram Island were the major study areas selected for this study. For more details see Balachandran (1995).

METHODS

The birds were caught with mesh nets and nooses, the traditional methods of professional bird trappers of coastal regions. Birds caught were ringed, aged, measured, weighed and examined for moult before being released.

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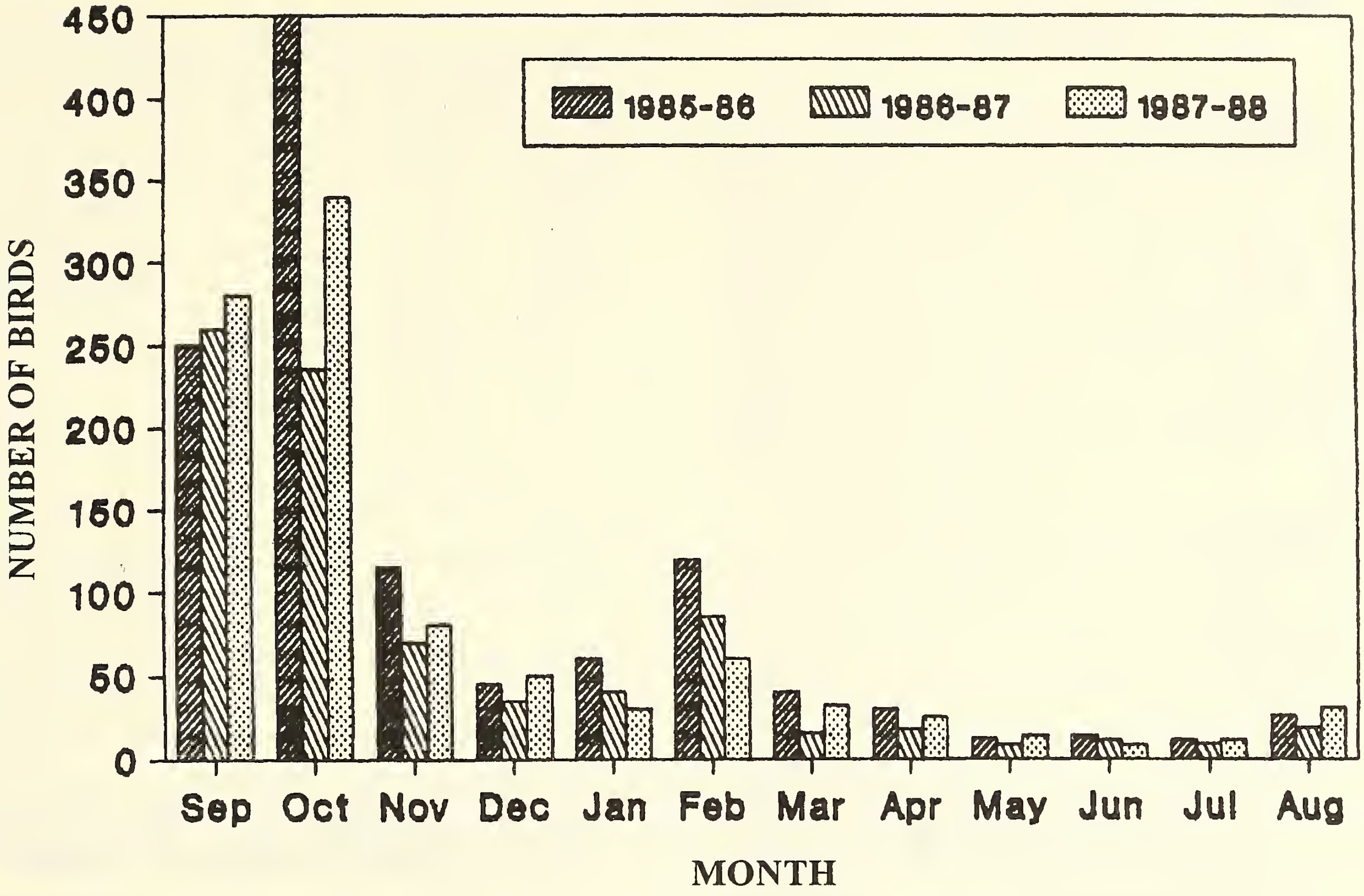

Fig. 1: Population fluctuation of large sand plover *Charadrius leschenaultii*

Birds were age-classified as 'adults' and 'first year' based on the characters described in the BTO Guide No. 17. 'Adult' refers to birds older than first year and includes second year birds from the first of August onwards. The term 'first year' refers to birds hatched in the same year.

Moult scoring was followed as in Snow (1967), wing, bill and tarsus were measured to the nearest millimetre (mm), and the birds weighed to the nearest gram (gm).

Monthly bird counts were carried out to determine the seasonal fluctuation in bird numbers. Though a few migrants started arriving in late August, the netting started from September onwards. Hence, each season commenced from September and ended in August. Thus, 1985-86, 1986-87, 1987-88 seasons are referred to as first, second and third seasons respectively.

RESULTS

Population fluctuation: The large sand plover arrived in low hundreds in September and October. The numbers were maximum in September and early October (300-450) due to the occurrence of transient individuals enroute to the other wintering grounds. They were found in lesser numbers (40-50) afterwards and till December end. A slight increase in their numbers was observed from the second half of January and February, probably due to the reappearance of transient individuals on their return journey to the breeding ground (Fig. 1). The maximum number of individuals counted for the three seasons was 450 in 1985-86. Some individuals, mostly first year birds, were found to spend the summer in Manali and Hare Is.

Age composition: Adults outnumbered first year birds in all the three seasons. The adult proportion was >70%. There is no significant variation in the adult/first year bird ratio for the three seasons. However, a slight decrease in the proportion of first year birds was observed in the second season (1986-87) (Table 1).

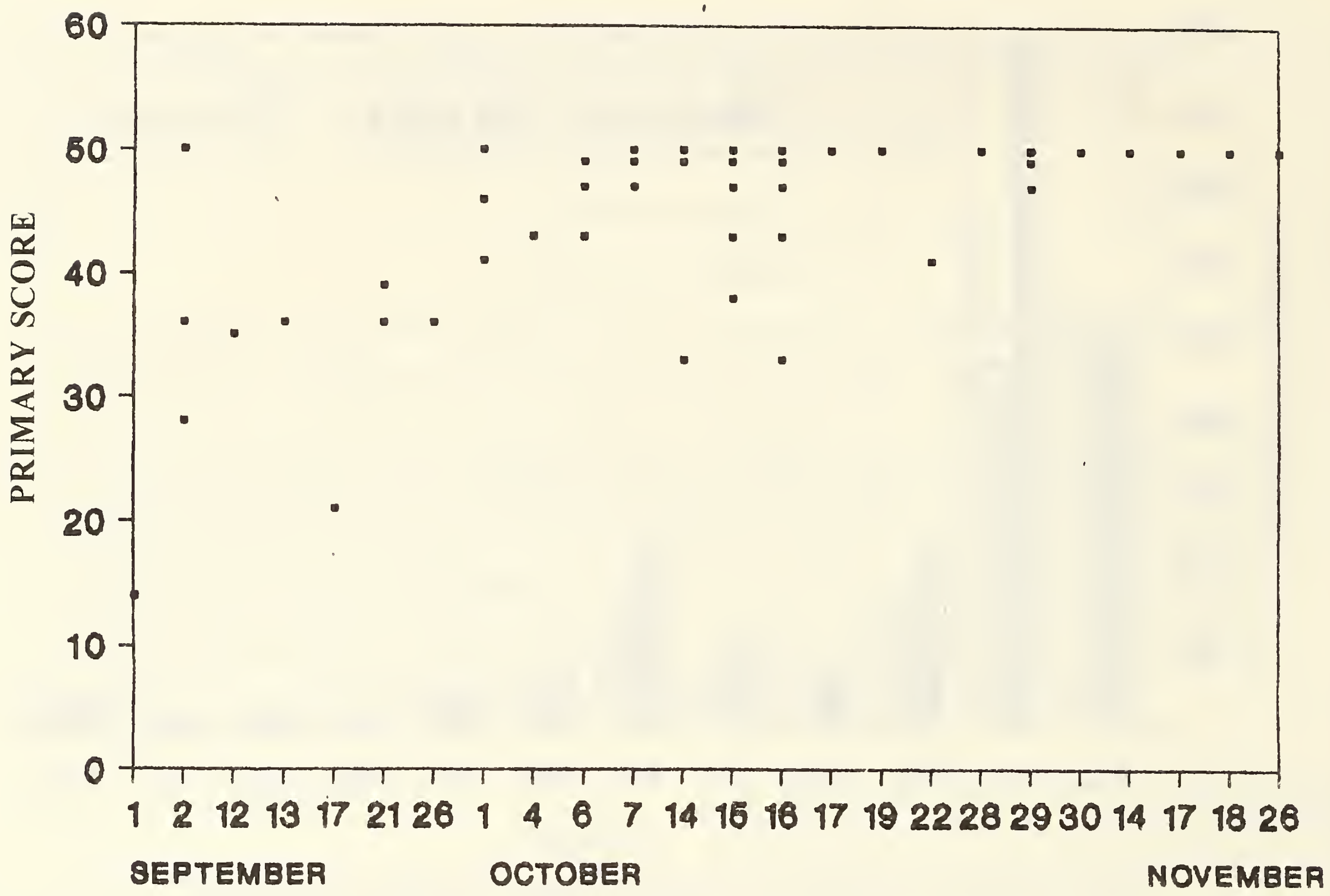

Fig. 2: Moult score vs date in large sand plover

TABLE 1

PROPORTION OF ADULT/FIRST YEAR BIRDS CAUGHT

Year	No.Ringed	No.Adult	No.1st year	% 1st year
1985-86	91	65	26	29
1986-87	30	22	8	26
1987-88	44	31	13	29

Primary moult: The majority of the birds caught in September were in advanced moult or complete moult, which indicates that the moult had already commenced either at breeding sites or on passage. One bird caught with a moult score of 14 in early September was the lowest to be recorded. Most of them completed their moult by late October (Fig.2), which is earlier by one month at least, than observed in northwestern Australia by Barter and Barter (1986) where they complete moulting between November and December. The same authors also estimated the duration of moult as 120 days. A second year bird, ringed as first year bird in the previous season and retrapped on October 1, had completed its moult. Hence, it is evident that birds observed with a moult score between 45-50 during September are second year birds. First year birds commenced their moult during the first week of April.

Site fidelity to wintering ground: Out of the 91 birds ringed in the first season, three birds each were recovered in the two subsequent seasons.

TABLE 2

BIOMETRICS OF LARGE SAND PLOVER CAUGHT AT GULF OF MANNAR

		Range in mm	Mean	S.D.	N
Wing	Adult	134-154	145.7	3.83	91
	1 year	127-152	142.3	5.31	44
Bill	Adult	22-26	24.0	1.06	109
	1 year	22-28	23.4	1.09	44
Tarsus	Adult	35-40	37.6	1.31	108
	1 year	35-40	37.6	1.1	44

TABLE 3
MEASUREMENT RANGE OF LARGE SAND PLOVER FROM OTHER SOURCES (in mm)

	Wing	Bill	Tarsus
C.l. columbinus	132-150	20-24	34-38
C.l. crassirostris	137-153	22-27	36-41
C.l. leschenaultii	136-149	21-25	34-39
	(Cramp and Simmons 1983)		
	132-153	20-28	34-41
	(Hayman *et al.* 1986)		
	134-150	24-27	35-38
	(Ali and Ripley, 1983)		

It is evident that site fidelity to the wintering ground exists in this species as in other waders.

The measurements obtained at GOM fall within the range given by the above mentioned authors, except for the wing length of the two "first year" birds, 5 mm shorter (127, 128 mm) than the minimum range given by all authors.

Weight changes: The weight varies from 59-95 gm. A maximum weight of 95 gm was recorded in March. However, the monthly average weight did not fluctuate much, being 73-79 gm. The maximum average weight was observed in January.

Subspecies: *C. leschenaultii columbinus* (Turkey and Jordan east to Caspian) is the shortest in bill length.

C. leschenaultii crassirostris (Caspian east to above Lake Balkash) is the largest in wing, bill and tarsus length.

C. leschenaultii leschenaultii (Mongolia, W. China and adjacent USSR) intermediate in bill length (Hayman *et al.*, 1986).

The bill length ranges from 22-28 mm for the birds caught at GOM. The absence of birds with shortest bill (20 and 21 mm) and a few birds with 22 mm bill length indicate that the species wintering at GOM does not belong to the race *columbinus*. However, the presence of birds with 23 mm and 24 mm bill length (intermediate bill length) and 25-26 mm (highest bill length) shows that the population probably includes both the races *leschenaultii* and *crassirostris*.

DISCUSSION

Individuals with maximum wing, bill and tarsus lengths indicate the occurrence of *C.l. crassirostris*. However, the average adult wing length (145.7 mm) and bill length (24 mm) obtained in the present study are much nearer to those observed by Barter and Barter (1986) in northwest Australia (143.8 and 23.8 mm respectively),which also confirms the presence of *C.l. leschenaultii*.

The moult duration (120 days) calculated, based on the feather growth rate from individuals retrapped in the same season by Balachandran (1990), is consistent with the duration estimated by Barter and Barter (1986) for the large sand plover in Australia. The completion of moult in second year birds observed at GOM was much earlier than other adults, which is also consistent with the findings of Cramp and Simmons (1986) on the primary moult of second year birds. The primary moult commenced elsewhere (probably on the breeding sites) and was completed without any suspension at GOM by the end of October. This period is one to two months earlier than in Australia, where these birds arrive with suspended moult. Due to suspended moult, the Australian wintering population completes the primary moult one to two months later than south Indian wintering birds. As GOM is much closer to the breeding ground than is Australia, the wintering population of India has to travel less distance than the wintering population of Australia. Hence, there is probably no need for the Indian population to suspend the moult.

Similarly, wintering birds in Australia gain more weight (120 gm in April) than in India (maximum 95 gm), to undertake the long return journey, as their wintering grounds are further away from the breeding grounds than are Indian wintering grounds. However, the average weight 73-79 gm observed during the non-migratory period in GOM is consistent with that observed in northwest Australia (73-76 gm) by Barter and Barter (1986).

Large sand plover wintering in GOM are faithful to the wintering sites, a habit that was also confirmed in the Australian wintering grounds.

ACKNOWLEDGEMENTS

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THE FISHES OF MUDUMALAI WILDLIFE SANCTUARY, TAMIL NADU, SOUTH INDIA[1]

MANIMEKALAN, A.[2]

(*With one text-figure*)

Key words: Western Ghats, Nilgiri Biosphere Reserve (NBR), Tamil Nadu, Mudumalai, hillstream fishes.

The paper describes 38 species of fishes belonging to 21 genera, 12 families and 8 orders from Mudumalai Wildlife Sanctuary, Tamil Nadu. Common names, vernacular names, notes on morphological characters — range of distribution, status and relative abundance have been discussed.

INTRODUCTION

Tamil Nadu with its 14 Wildlife Sanctuaries and 5 National Parks has a vast network of protected areas covering *c.* 2834 sq. km, i.e. 12.48% of the total forest area (Venkataraman 1995). Mudumalai Wildlife Sanctuary (MWS) forms 11.32% of the total protected area in the state. Increasingly, decisions affecting park resources are made with limited biological information especially for little known groups such as fishes. Forest managers need accurate assessments of the occurrence of species or genotypes, and the status of their populations. These assessments are essential to form natural resource management policies, to manage the natural diversity and to identify potential areas of high conservation value.

This paper describes the fishes of Mudumalai Wildlife Sanctuary, with a note on their distribution and morphological characters. As in earlier studies (Hora 1941, Hora and Law 1941, Hora 1942, Rajan 1955, 1963; Silas 1951a, b; Rema Devi and Indra 1986) peninsular India, especially the hill ranges lying in the Nilgiris, has proved to be an ideal site for ichthyological studies, as physiography has contributed to the presence of diverse fish fauna.

STUDY AREA

Mudumalai Wildlife Sanctuary is situated in Nilgiri dist., Tamil Nadu (11° 30' to 11° 39' N Lat., 76° 27' to 76° 43' E Long.), an area of 321 sq. km, which includes 103 sq. km of National Park (Fig. 1). The sanctuary is bounded by Bandipur Tiger Reserve (Karnataka) on the north, by Wynaad Sanctuary (Kerala) on the northwest, by vast stretches of Sigur reserve forest (Tamil Nadu) towards the east and by private coffee and tea estates to the south. The altitude ranges between 1258 m (Morganbettea) and 625 m (Moyar Reserve Forest). The terrain is gently undulating in the western portion, while the eastern portion is almost flat. Annual rainfall ranges from 800 to 1800 mm. The forest types vary from open thorny scrub to hilltop evergreen forest. Dry as well as moist deciduous forests form a large portion of the sanctuary. Teak plantations are also common. MWS has four major administrative ranges: 1. Kargudi range (54.6 sq. km), 2. Theppakadu range (89.5 sq. km),

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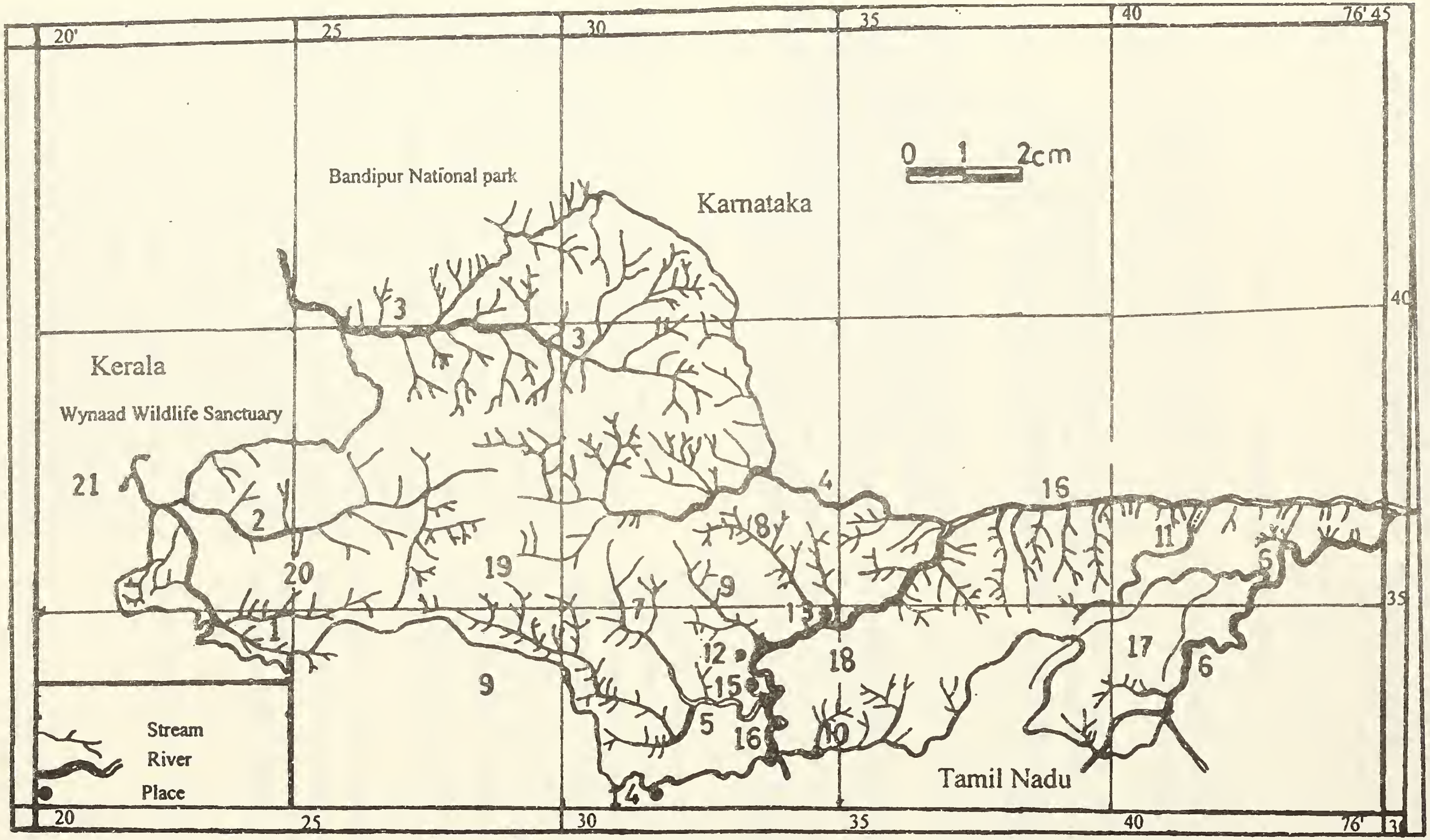
Bandipur National park
Karnataka
0 1 2cm
Kerala
Wynaad Wildlife Sanctuary
Tamil Nadu
Stream
River
Place
20'
25
30
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76'
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1. Mukkatti hole, 2. Benne hole, 3. Mavin halla, 4. Kakkan halla 5. Bidar halla, 6. Sigur pallam, 7. Ombatta todu, 8. Kal halla, 9. Hosheri halla, 10. Sigur river, 11. Moyar Canal (Moyar power house), 12. Kargudi, 13. Teppakadu, 14. Vallatottam, 15. Abhayaranyam, 16. Thorapalli, 17. Avarahalla RF, 18. Moyar Reserved Forest, 19. Kumbarakolli RF, 20. Benne Reserved Forest, 21. Nulpuzha.

Fig. 1: Streams and Rivers of Mudumalai Wildlife Sanctuary

Mudumalai range (96.6 sq. km) and Masinagudi range (80.4 sq. km).

Streams and river: Mudumalai is a remarkably well watered sanctuary (Davidar 1985). Besides the Moyar and Sigur rivers, their tributaries called *halla,* meaning water course, run deep into the sanctuary. The flume channel taking water from the Sinkara powerhouse to the Moyar powerhouse lower down, with its regulatory dam at Maravankandy and its seepage, form yet another water complex. Moyar and its tributaries, along with the perennial river and streams via Sigur river, Bidar halla, Kakan halla, Mavan halla, Mavin halla, Imbar halla, Mukkatti hole and Avara halla are the major water sources of the sanctuary and they provide suitable habitats for fishes in the sanctuary.

Mukkatti hole originates from Mukkitti reserve forest and joins Nul Puzha in Nul reserve forest of Kerala. Benne hole starts near Kapur and runs out to the sanctuary and joins Mukkatti hole near Kaniyaram, outside the Sanctuary area and finally joins Nul Puzha in Kerala. Mavin halla forms the boundary between Kerala and Tamil Nadu on the northwestern side. Kakkanhalla forms a boundary between Karnataka and Tamil Nadu. Kakkan halla is fed by its tributary Imbar halla. Bidar halla joins Moyar 2 km from Abhayaranyam. Its tributary, Ombatta Todu, forms the Ombatta swamp before it joins Bidar halla.

Sigur river, with its tributaries Mavan halla and Avara halla, enters MWS near Vallatottam at the southeastern part of the sanctuary. River Sigur joins Moyar at Pathattipatti. It forms the sanctuary boundary on the southeast.

Moyar river supported by 5 tributaries is the only major river in the sanctuary. It enters MWS near Thorapalli at the middle of the southern end and runs through Abhayaranyam, Kargudi, Teppakadu (where it forms MGR fall) and then runs along the boundary between Karnataka and Tamil Nadu. While Karimara hole joins Moyar just outside the southern boundary of the sanctuary, Bidar halla (near Abhayaranyam), Hosheri halla (near Kargudi) and Kal halla (near Theppakadu) feed the river inside the sanctuary. Kakkan halla, that forms the northern boundary of the sanctuary, joins Moyar after MGR fall.

Methodology: Sampling was carried out seasonally during 1995-96 using cast nets, gill nets, scoop nets and drag nets. To minimise the collection from the wild, one voucher specimen of each species was collected and preserved in 10% formalin (Victor and Meye 1994) for identification and laboratory work. Morphological features of each species were measured following Moyle and Senanayake (1984). Identification of the species was carried out following Day (1865), Jayaram (1981), and Talwar and Jhingran (1991). The recent classification of Nelson (1984) was followed.

Results and Discussion: A total of 38 species belonging to 21 genera, 12 families and 8 orders have been collected and identified during the study from the sanctuary. Common and vernacular names (Kan-Kannada, Mal-Malayalam, Tam-Tamil), diagnostic features, range of distribution and general status of the species are discussed.

Mudumalai sanctuary has the unique distinction of having a large number of rare and endemic fish species. Out of 38 species collected, 27 species belong to Cyprinidae. 36 species are native and two are introduced species. 39% of the total species are uncommon or rare and endemic. The sanctuary harbours four species, *Puntius mudumalaiensis, Danoi neilgheriensis, Puntius melanostigma* and *Mystus punctatus,* endemic to Nilgiri Biosphere Reserve. While *P. mudumalaiensis* is exclusive to MWS (Menon and Rema Devi 1992), the other three species were found elsewhere in the NBR. Only two individuals of *Tor khudree,* an endangered species, were collected during our study. All the specimens were preserved in 10% formalin and are deposited at the Sálim Ali Centre of Ornithology and Natural History (SACON).

Description of the species

Order: Anguilliformes
Family: Anguillidae

1. *Anguilla bengalensis* (Gray)

Salient features: D. 250-300; P. 18; A. 218-248; C. 10-12.

Common name: Indian long-fin eel

Vernacular name: Kan - Karimenu; Mal - Vilangu, Mlanjil; Tam - Velangoo.

Diagnosis: Body elongate; mouth terminal; angle of mouth behind posterior margin of eye; dorsal fin inserted nearer anus than gill-opening; colour yellowish, mottled with dark brown.

Locality and range: Moyar near Kargudi; throughout India.

Relative abundance: Not common.

Order: Cypriniformes
Family: Cyprinidae

2. *Cirrhinus reba* (Hamilton)

Salient features: D. 1/8; P. 1/6; V. 1/9; A. 1/6; C. 8/18.

Common name: Reba carp.

Vernacular name: Kan - Bathili, Thari meenu, Arja; Mal - Reba; Tam - Arijan kendai, Kull arinjan, Poorali, Pillarinjan.

Diagnosis: Body elongate; depth more than head length; one pair of short rostral barbels; pectoral fin as long as head; caudal deeply forked; lateral line complete with 34-38 scales; lateral transverse 7/6; Colour silvery on sides; greyish back, anal and pelvic fins orange tipped.

Locality and range: Moyar; throughout India.

Remarks: It is a planktivorous fish and can be cultivated in ponds. Commonly available in the Cauvery river.

Relative abundance: Not common.

3. *Cyprinus carpio* Linnaeus

Common name: Common carp.

Diagnosis: Body stout; head triangular; mouth small and oblique; thick lips; 2 pairs of barbels; dorsal fin inserted midway between snout and base of caudal; dorsal spine serrated; scales large; lateral line with 30-40 scales; colour silvery to golden, fins yellowish to golden.

Locality and range: Moyar; throughout India.

Remarks: The common carp has three recognised varieties: *C. carpio* var. *communis* (scale carp), *C.c.* var. *nudus* (leather carp) and *C.c.* var. *specularis* (mirror carp). The mirror carp was brought from Sri Lanka in 1939 and stocked in the Ooty lake (Tamil Nadu). This fish is an omnivorous bottom dweller.

Relative abundance: Not common.

4. *Labeo bata* (Hamilton)

Salient features: D. 2-3/9-10; P. 1/16-17; V. 1/8; A. 3/5-6.

Common name: Bata.

Vernacular name: Tam - Kindameen, Sinakannan meen.

Diagnosis: Body elongate, snout slightly projecting, with pores; lower lip slightly fringed; 1 pair minute maxillary barbels; lateral line with 37-40 scales; predorsal scales 10-13; colour-golden yellow on back, silvery on sides, irregular black blotch present on 4th-6th lateral line scales, pelvic and anal fins dark with orange red tips.

Locality and range: Confluence of Moyar and Kakkan halla; Krishna, Cauvery and Godavari river systems.

Remarks: It is a minor carp, having a maximum length of 610 mm.

Relative abundance: Rare.

5. *Puntius bimaculatus* (Bleeker)

Salient features: D. 4/7-8; P. 1/14-15; V. 1/8; A. 3/5.

Common name: Two-spot barb.

Diagnosis: Elongate body; one pair of barbels; dorsal ray weak; lateral line complete with 24-25 scales; predorsal scales 8 to 10; back olive green, black spot at base of 3rd to 8th ray of dorsal fin; black spot at end of lateral line on 23rd and 24th scale.

Locality and range: Moyar; Kalakkad.

Remarks: Grows upto 60 mm.

Relative abundance: Rare.

6. *Puntius bovanicus* (Day)

Salient features: D. 4/9-10; P. 1/18; V. 1/8; A. 3/6.

Common name: Bhavani barb.

Vernacular name: Tam - Bhavani kendai

Diagnosis: Body elongate; no bands or spots; four well developed barbels; dorsal ray osseous, strong and smooth; lateral line complete with 24-26 scales; greenish colour with a golden tinge, darkest along the back.

Locality and range: Moyar; Bhavani river, Cauvery river and its tributaries at the base of the Nilgiri hills, Tamil Nadu.

Remarks: A rare barb with restricted distribution.

Relative abundance: Rare.

7. *Puntius carnaticus* (Jerdon)

Salient features: D. 4/8; P. 2/15-16; V. 1/8; A. 2/6; C.6/18.

Common name: Carnatic Carp.

Vernacular name: Kan - Gendai; Mal - Kavery kenta; Tam - Pulli kendai, Poaree candee, Saal kendai.

Diagnosis: Deep bodied; no bands or spots; four barbels; dorsal ray osseous, strong and smooth; lateral line curved, complete, with 28-31 scales; predorsal scales 10-12; dark olive green back, dull white on abdomen and sides; fins dusky, outer margin of dorsal fin black. 'V' shaped marking on the caudal.

Locality and range: Moyar; Krishna and Cauvery river system - Nilgiris, Wynaad and Canara.

Remarks: It grows to a fairly large size, upto 12 kg in weight.

Relative abundance: Common.

8. *Puntius chola* (Hamilton)

Salient features: D. 3/7-8; P. 1/14; V. 1/8; A. 2/5

Common name: Chola barb, swamp barb, green barb.

Vernacular name: Kan - Dhoddakarse; Mal - Poovali kendai, koroon; Tam - Korron, Putti kendai, Macha kendai, Vannathi.

Diagnosis: Deep bodied; no bands; one pair of barbels; dorsal fin ossified, spine smooth; lateral line complete with 24 to 29 scales; black spot after gill opening and caudal base.

Locality and range: Mavan halla and Moyar; throughout India.

Remarks: Fairly common in coastal areas of Tamil Nadu and Kerala.

Relative abundance: Not common.

9. *Puntius dorsalis* (Jerdon)

Salient features: D. 4/8; P. 1/13-14; V. 1/8; A. 3/5-6.

Common name: Long-snouted barb.

Vernacular name: Kan - Markakka; Tam - Kendai.

Diagnosis: Body elongate; one pair of barbels; last unbranched dorsal ray osseous, strong and smooth; lateral line complete with 22-28 scales; predorsal scales 8 to 10. Colour olive dorsally, silvery sides, fins orange. A black blotch on tail.

Locality and range: Mavin halla; Krishna and Cauvery river systems.

Remarks: Grows upto 150 mm.

Relative abundance: Rare.

10. *Puntius filamentosus* (Valenciennes)

Salient features: D. 2/7; P. 1/14; V. 1/8; A. 1/5; C. 6/16.

Common name: Tiger barb, black spot barb.

Vernacular name: Mal - Kachi parval;

Tam - Chevalle, Machakendai.

Diagnosis: Elongate body; one pair rudimentary maxillary barbels; dorsal ray prolonged upto caudal base; third ray longest; lateral line complete with about 21 scales; black spot on caudal peduncle.

Locality and range: Sinkaara; Krishna and Cauvery drainages.

Remarks: It also breeds in ponds. Four black vertical stripes on a pink body in juveniles. As the fish matures, the stripes disappear and only one remains as a horizontal oval spot on the caudal peduncle.

Relative abundance: Not common.

11. ***Puntius melanostigma*** (Day)

Salient features: D. 2/8; P. 1/14; V. 1/8; A. 2/5.

Common name: Wynaad barb.

Vernacular name: Mal - Kudukunda; Tam - Macha kendai.

Diagnosis: Elongate body; no vertical colour bands; one pair of maxillary barbels; dorsal ray weak and osseous; lateral line complete with 23 to 26 scales; predorsal scales 8; silvery colour; deep black blotch on base of caudal fin.

Locality and range: Moyar and Bidar halla; Cauvery river system, Wynaad hills and Bhavani river.

Remarks: Grows upto 100 mm.

Relative abundance: Rare.

12. ***Puntius mudumalaiensis***
Menon and Rema Devi

Salient features: D. 4/8; P. 13; V. 1/8, A. 3/5; C. 1/17.

Diagnosis: A small *Puntius* with proportionately big head with a deep body; one pair of maxillary barbels; weak and articulated dorsal spine; lateral line incomplete; 2 blotches, one on dorsal base and the other on caudal peduncle.

Locality and range: Mudumalai-Kakkan halla; Nilgiris.

Remarks: Attains a maximum length of 230 mm.

Relative abundance: Rare and endemic.

13. ***Puntius sarana sarana*** (Hamilton)

Salient features: D. 3/8; P. 1/15; V. 1/8; A. 3/5.

Common name: Olive barb.

Vernacular name: Kan - Gid-pakka; Mal - Kuruka; Tam - Pingella, Panjelai kendai, Pallu kendai.

Diagnosis: Body elongate; four barbels; dorsal ray osseous and serrated; lateral line complete with 30-33 scales; each scale has long black lines and dark border posteriorly.

Locality and range: Moyar; south of Krishna river.

Remarks: It is found in ponds, lakes and rivers. It grows to 600 mm length and breeds during the monsoon.

Relative abundance: Common.

14. ***Puntius sarana subnasutus*** (Valenciennes)

Common name: Peninsular Olive barb

Diagnosis: Body oblong; four barbels; dorsal ray osseous and fairly strong; lateral line complete with 28-31 scales; predorsal scales 10; colour silvery on back fading to white beneath; a dark band behind opercular and a black blotch on the 24th scale of the lateral line; fins orange.

Locality and range: Benne hole; Krishna and Cauvery river systems and south of it.

Remarks: Common in Kerala backwaters.

Relative abundance: Not common.

15. ***Puntius ticto*** (Hamilton)

Salient features: D. 2/7; P. 1/9-10; V. 1/8; A. 2/5; C. 6/16-18.

Common name: Ticto barb, Tic-tac-toe Barb, fire fin barb.

Vernacular name: Mal - Kadum kali; Tam - Palli kendai.

Diagnosis: Deep bodied; barbels absent; dorsal ray short, osseous and serrated; lateral line complete or incomplete; a black blotch on 3rd, 4th or 5th lateral line scale and another between scales 16-20.

Locality and range: Moyar, Ombatta and Kakkan halla; widely distributed in India.

Remarks: A popular aquarium fish, preferred for its iridescence and red edging on the dorsal fin. The fish shows variable colouration, lateral line scales, etc.

Relative abundance: Rare.

16. *Puntius wynaadensis* (Day)

Salient features: D. 4/9; P. 1/16-17; V. 1/8; A. 3/5-6.

Salient features: Wynaad barb.

Diagnosis: Deep bodied, dorsal spine weak and articulated, two pairs of well developed barbels; eight rows of sensory pores below eye; cartilaginous pad on lower jaw; lateral line complete, curved with 28-29 scales; predorsal scales 10; mid-dorsal streak and faint line along the sides above lateral line.

Locality and range: Kakkan halla and Moyar; Wynaad and headwaters of the Cauvery river.

Remarks: Grows upto 250 mm.

Relative abundance: Rare.

17. *Tor khudree* (Sykes)

Salient features: D. 4/9; P. 1/14; V. 1/8; A. 2/7-8.

Common name: Deccan Mahseer, Yellow Mahseer.

Vernacular name: Kan - Bili meen; Tam - Biriga, Poomeen, Peruval.

Diagnosis: Body elongate; snout covered with indistinct tubercles; eyes visible from underside of head; four barbels; lower lip protruding; pectoral fins short; large scales; lateral line scales 25-27; colour silvery with yellow below lateral line, belly bluish, eyes red, fins bluish grey.

Locality and range: Moyar near Kargudi; Deccan (Krishna and Godavari river systems of Peninsular India).

Remarks: It grows to 450 mm and about 22 kg in weight.

Relative abundance: Critically endangered.

Subfamily: Rasborinae

18. *Barilius bendelisis* (Hamilton)

Salient features: D. 2/7, P. 1/10, V. 1/8, A. 2/8, C. 6/19.

Common name: Hill trout.

Vernacular name: Mal - Pavakan; Tam - Vennathi kendai.

Diagnosis: Body shallow; jaws long; four short barbels; poorly developed tubercles on snout and lower jaw; dorsal fin inserted in advance of anal fin; lateral line scales 40-45; predorsal scales 18-20; colour greyish black, sides silvery, with 8-10 dark vertical bands.

Locality and range: Throughout the sanctuary; India.

Remarks: It grows to about 150 mm and is fairly common in the region.

Relative abundance: Very common.

19. *Barilius gatensis* (Valenciennes)

Salient features: D. 1/10; P. 1/10; V. 1/8; A. 2/11; C. 6/18.

Common name: Hill trout, river carp.

Vernacular name: Mal - Pavakan.

Diagnosis: Active stream fish with a deep body; two minute rostral barbels; dorsal fin inserted in advance of anal fin; tubercles on head well developed; lateral line with 40-41 scales; predorsal scales 15; colour silvery grey with 13-15 vertical bars.

Locality and range: Mavin halla; Western Ghats - Maharashtra, Karnataka, Tamil Nadu and Kerala.

Remarks: Grows to 150 mm.

Relative abundance: Rare.

20. *Danio aequipinnatus* (McClelland)

Salient features: D. 2/10; P. 1/9; V. 1/5; A. 2/13; C. 8/18.

Common name: Blue or Giant Danio.

Vernacular name: Tel - Vannathipodi; Tam - Selai parvai, Vananthipodi.

Diagnosis: Body elongate and compressed; pre-orbital spine present on the lachrymal bone; mouth directed upwards; four short barbels; lateral line complete with 35-37 scales; predorsal scales 15; colour brilliant blue with well developed lateral dark blue bands, on the sides of which are thinner golden bands, fins bright orange.

Locality and range: Throughout the Sanctuary; throughout India.

Remarks: It is widely distributed throughout India and is an attractive aquarium fish. It grows to 150 mm and prefers hill streams.

Relative abundance: Very common.

21. *Danio neilgherriensis* (Day)

Salient features: D. 1/11; P. 1/9; V. 1/6; A. 1/10; C. 6/18.

Common name: Peninsular Danio.

Vernacular name: Tam - Kowlei.

Diagnosis: Body elongate and compressed; mouth small and obliquely directed upwards; four short barbels; dorsal fin inserted in advance of anal fin; lateral line complete with 38 scales; predorsal scales 16-18; colour silvery with greenish back, a steel blue stripe along the sides.

Locality and range: Confluence of Moyar and Ombatta; Tamil Nadu (Nilgiri hills).

Remarks: It grows to about 100 mm.

Relative abundance: Rare.

22. *Esomus barbatus* (Jerdon)

Salient features: D. 2/6; P. 1/14; V. 1/8; A. 3/5

Common name: South Indian flying barb.

Vernacular name: Tam - Messai paravai

Diagnosis: Body elongate and strongly compressed; mouth small; four barbels, maxillary barbels extended upto middle of pectoral fin; pectoral fins long but do not extend upto pelvic fins; lateral line complete with 30-32 scales; predorsal scales 17; colour silvery with an indistinct streak on the side.

Locality and range: Confluence Ombatta and Ombatta thodu; Karnataka and Tamil Nadu.

Remarks: It grows to 120 mm.

Relative abundance: Not common.

23. *Parluciosoma daniconius* (Hamilton)

Salient features: D. 3/13; P. 1/12-13; V. 1/8; A. 1/6; C. 8/18.

Common name: Blackline rasbora

Vernacular name: Kan - Neddean jubbu, Kolkane, Kolainjan kendai, Mal - Kannanjan; Tam - Jobidayee, Narangi

Diagnosis: Body oblong and compressed; lips simple; pectoral fins short; lateral line complete with 34 scales; colour silvery with dark back, a distinct dark band on the sides flanked with gold.

Remarks: Commonly found in almost all aquatic habitats, it grows to 100 mm.

Locality and range: Throughout Mudumalai; throughout India.

Relative abundance: Very common.

Subfamily Garrinae

24. *Garra gotyla stenorhynchus* (Jerdon)

Salient features: D. 3/8; P. 6/9; V. 2/7; A. 2/5; C. 6/17.

Common name: Stone sucker, Nilgiri garra.

Vernacular name: Mal - Kallangkari: Tam - Kal kaagan.

Diagnosis: Body elongate and subcylindrical; depth of body 5 or more times in standard length; snout with a proboscis; 4 barbels; lateral line scales 32-35; predorsal scales 8-10; colour greyish above and pale on the sides, a black spot on operculum.

Locality and range: Throughout the sanctuary; Western Ghats - Krishna and Cauvery river systems.

Remarks: Grows to 150 mm. An ideal example of morphological adaptation to stream habitat.

Relative abundance: Common.

25. *Garra mullya* (Sykes)

Salient features: D. 2/8; P. 2/10-11; V. 1/8; A. 1/5; C. 4/18.

Common name: Stone carp, Mullya garra.

Vernacular name: Kan - Pandi pakka; Mal - Kamau, Kallu nakki; Tam - Kallu koravai.

Diagnosis: Body depth four times in standard length; snout rounded and marked by a deep transverse groove; mouth small; four barbels; caudal fin emarginate; lateral line scales 32-34; predorsal scales 9-11; dorsal side dark, belly white, broad lateral band on the sides. A distinct red spot on operculum.

Locality and range: Moyar and Kakkan halla; India.

Remarks: Specimens from widely separated river systems show morphological variations in size of mental disc, shape, colouration, etc.

Relative abundance: Not common.

Family: Cobitidae
Subfamily: Cobitinae

26. *Lepidocephalus thermalis* (Valenciennes)

Salient features: D. 3/6; P. 1/7; V. 1/6; A. 3/5.

Common name: Malabar loach.

Vernacular name: Mal - Ayira; Tam - Assaree, Assari meen.

Diagnosis: Body elongate; mouth inferior; six barbels; dorsal fin inserted anterior to pelvic fin; caudal fin truncate; scales present on anterior side of pectoral fin base; colour greyish green with 8 to 10 irregular blotches on sides; dorsal and anal fins with rows of spots.

Locality and range: Kakkan halla and Mavin halla; Maharashtra, Karnataka and Kerala.

Remarks: Grows upto 80 mm. This species exhibits wide variation in colour pattern in different river systems.

Relative abundance: Not common.

Family: Balitoridae
Subfamily: Noemacheilinae

27. *Noemacheilus denisoni denisoni* Day

Salient features: D. 3/8; P. 1/10; V. 1/6; A. 3/5.

Diagnosis: Eight branched dorsal fin rays; pelvic touching the anal opening; caudal deeply emarginate with rounded lobes; lateral line incomplete, ending in front of dorsal fin; body with varying number of brown bands, more distinct behind dorsal fin; predorsal distance 22.5-55.5% of SL.

Locality and range: Kakkan halla and Mavin halla; Peninsular India, Bastar (M.P.), Pamba and the Kollur drainages of Kerala and Karnataka respectively.

Remarks: Grows to a maximum length of 50 mm. Commonly caught by tribals using traditional methods.

Relative abundance: Common.

28. *Noemacheilus nilgiriensis* Menon

Salient features: D. 3/8; P. 1/9-10; V. 1/6; A. 2/6.

Diagnosis: Eight branched dorsal fin rays; pelvic separated from anal opening by a considerable distance; lateral line incomplete, terminating above tip of pectoral fin; caudal emarginate; body with 11-12 brownish vertical bands.

Locality and range: Moyar; Pykara dam, Nilgiri district, Tamil Nadu.

Remarks: Maximum length 51 mm.

Relative abundance: Rare. Endemic to Nilgiris.

Order: Siluriformes
Family: Bagridae

29. ***Mystus cavasius*** (Hamilton)

Salient features: D. 1/7; P. 1/8; V. 1/5; A. 4/9.

Common name: Gangetic mystus, Dwarf catfish.

Vernacular name: Kan - Naii kirle; Tam - Solai kelunthi.

Diagnosis: Body elongate and compressed; head conical; occipital process extends to dorsal fin base; branchiostegal rays six; eight barbels, maxillary barbels extend beyond caudal fin base; dorsal spine weak; colour greyish with a longitudinal stripe.

Locality and range: Throughout the Sanctuary; India.

Remarks: It grows to about 500 mm.

Relative abundance: Not common.

30. ***Mystus punctatus*** (Jerdon)

Salient features: D. 1/7; P. 1/8; V. 1/5; A. 4/8.

Common name: Nilgiri Mystus.

Vernacular name: Tam - Sholang kellete

Diagnosis: Body elongate and compressed; head depressed; occipital process not extending to dorsal fin base; eight barbels, maxillary barbels extend to end of pelvic fins; dorsal spine strong and serrated on upper portion; branchiostegal rays 11; colour greyish dorsally with yellowish sides, 10 black spots along lateral line.

Locality and range: Ombatta swamp; Western Ghats - Nilgiri hills.

Remarks: It grows to about 450 mm.

Relative abundance: Rare.

Family: Siluridae

31. ***Ombak bimaculatus*** (Bloch)

Salient features: D. 4; P. 1/13-14; V. 1/8; A. 3/58-59.

Common name: Indian butter-catfish.

Vernacular name: Mal - Manjivhala; Kan - Godla; Tam - Silaivhalai; Chottavala.

Diagnosis: Body elongate and strongly compressed; mouth large and oblique; four barbels, maxillary barbels extend to anal fin; anal fin long with 57-58 branched rays; colour silvery with a large shoulder spot on the lateral line, a small blotch on the caudal peduncle.

Locality and range: Ombatta swamp; India.

Remarks: Grows to about 450 mm; found in rivers, tanks and ponds.

Relative abundance: Common in Ombatta swamp.

Family: Sisoridae

32. ***Clarias dayi*** Hora

Salient features: D. 68-69; P. 1/11; V. 1/5; A. 55-59.

Common name: Magur, Air-breathing catfish.

Vernacular name: Mal - Muzhi; Tam - Masarai; Kan - Hali meenu.

Diagnosis: Body elongate, head depressed; mouth terminal; eight barbels, short, not extending beyond eyes; nasal barbels shorter than half head length, dorsal fin inserted behind pectoral fin tip; pectoral spine strong and serrated on its outer edge only; colour dark on back, lighter on sides.

Locality and range: Ombatta swamp; Wynaad hills, Kerala.

Remarks: Day collected a single specimen measuring 175 mm.

Relative abundance: Rare.

Order: Cyprinodontoformes
Family: Poecilidae

33. ***Gambusia affinis*** (Baird and Girard)

Salient features: D. 1/8; P. 14; V. 6; A. 9-10.

Common name: Mosquito fish.

Diagnosis: Body elongate, depth 3.5 to 4 times the standard length; eyes large; in males the dorsal fin is inserted in middle of body while in females it is midway between front margin of eye and tip of caudal fin; gonopodium as long as head length; colour greyish with isolated black spots on body.

Locality and range Ombatta; India.

Remarks: It was introduced into Indian waters in 1928 from Italy under an antimalarial programme. It grows to about 60 mm, is a very hardy fish and can survive in diverse habitats.

Relative abundance: Not common.

Order: Channiformes
Family: Channidae

34. *Channa marulius* (Hamilton)

Salient features: D. 50-55; P. 17-18; V. 6; A. 30-36.

Common name: Giant snakehead, murrel.

Vernacular name: Kan - Aviuu; Mal - Curuva, Cherumeen;Tam - Puveral, Aviri, Coaree veral.

Diagnosis: Body elongate; mouth large; scales of moderate size; cluster of head scales between the orbits, frontal head scales occupying centre of cluster; 10 rows of scales between preopercular angle and posterior border of orbit; lateral line scales 60-70; predorsal scales 16; colour greyish green above lateral line, blotches of pale yellow below lateral line; distinct white spots scattered on the body; dorsal and anal fins also with white spots; caudal fin with white spots arranged into vertical bands; distinct ocellus at base of caudal fin, in the upper portion.

Locality and range: Ombatta swamp, Mavan halla and Kakkan halla; throughout India.

Remarks: A good sport fish, growing to 1220 mm. It prefers large lakes and rivers with sandy to rocky bottom. It is a highly aggressive carnivore in nature.

Relative abundance: Rare.

35. *Channa orientalis* Bloch and Schneider

Salient features: D. 34-37; P. 14-15; V. 6; A. 22-23.

Common name: Brown snakehead.

Vernacular name: Kan - Mottu, Mohkorava; Mal - Karayu, Bral, Vatton; Tam - Para koravai, Manian koravai.

Diagnosis: Body elongate; mouth large; pectoral fins extend to anal fin; dorsal fin rays 32-37; length of pelvic fin less than 50% of pectoral fin length; scales on longitudinal series 40 to 50; colour dorsal side greenish, ventral side pale with bluish tinge. Pectoral fins with a series of vertical bands.

Locality and range: Mavan halla and Kakkan halla, Ombatta swamp; India.

Remarks: Fairly common species in the Western Ghats. It is of some fishery value in Maharashtra.

Relative abundance: Not common.

Order: Perciformes
Family: Cichlidae

36. *Oerochromis mossambica* (Peters)

Salient features: D. 16/12; P. 15; V. 1/5; A. 3/11.

Common name: Tilapia.

Vernacular name: Kan - Tilapia; Mal - Tilapi;Tam - Thillappi, Jilabimeen.

Diagnosis: Body elongate and compressed; mouth large and terminal; dorsal fin inserted above base of pectoral fin with 15-16 spines; scales cycloid; scales in lateral series 30-32; colour greyish with 3-4 dark blotches on side; dorsal fin with red margin, pectoral fin translucent.

Locality and range: Moyar near Theppakadu; India.

Remarks: Introduced in 1952 and has now spread at an alarming rate to almost all the major river systems.

Relative abundance: Very common.

Family: Gobidae

37. *Glossogobius giuris* (Hamilton)

Salient features: D. 4+1/9; P. 1/20; A. 1/8.

Common name: Tank gobi.

Vernacular name: Tam - Vuluvai.

Diagnosis: Body elongate, anteriorly cylindrical and compressed; head depressed; mouth oblique; tongue bilobed; gill openings continued far forward; colour yellowish brown without longitudinal lines, iris without process in eye.

Locality and range: Ombatta swamp; India.

Remarks: It grows to about 250 mm and is fairly common in the rivers of the Western Ghats. It prefers deeper waters.

Relative abundance: Rare.

Order: Mastacembeliformes

Family: Mastacembelidae

38. *Mastacembelus armatus* (Lacepede)

Salient features: D. 36-38/88; P. 26; A. 3/85.

Common name: Tyre-track spiny eel.

Vernacular name: Mal - Mookkan arakan, Aaron; Tam - Kul aral.

Diagnosis: Body eel-like and slender; dorsal fin with 32-40 spines and 64-92 soft rays; dorsal and anal fins broadly joined to caudal fin; colour brownish with wavy lines forming a network, dorsal and anal fins banded.

Locality and range: Moyar; India.

Remarks: It grows to about 500 mm and is one of the largest spiny eels in India.

Relative abundance: Rare.

CONSERVATION MEASURES

Various human activities such as deforestation, construction of dams, discharging industrial effluents into rivers, dynamiting, over fishing and introduction of exotic fishes are responsible for loss of fish diversity of the region (Menon 1992). Considering the major threat to fishes in MWS is mainly poisoning and occasional dynamiting along the border area, the following conservation measures are suggested:

1. Mass poisoning of fishes using different plant parts should be banned inside the sanctuary.
2. Fishing should be restricted to angling.
3. Establishment of fish sanctuaries, especially near large natural pools along the course of the stream/river. Fishing activities should be restricted in these habitats.
4. Fishing during the breeding season (March-July and October-December) should be avoided.
5. Riparian vegetation can be established to provide good food resources for fish.
6. Environmental awareness programmes regarding importance of conserving fish and fish habitats should be initiated in the villages inside the Sanctuary. Poster campaigns on rare and endemic species will be very useful.

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FUNCTIONAL ASPECT OF THE INTROMITTENT ORGANS OF NON-TIBIAROLIATE ASSASSIN BUGS, HETEROPTERA:REDUVIIDAE[1]

Ravichandran, G.[2], D. Livingstone[3] and Muthukrishnan, J.[2]

(*With three text-figures and one plate*)

Key words: Assassin bugs, non-tibiaroliate, intromittent organs, spermatophore, male genitalia

The male intromittent organs of Harpactorinae, Stenopodainae, Emesinae, Saicinae and Holoptilinae have been structurally and functionally analysed.

Introduction

In Reduviidae, the morphology of the male genitalia has been so far studied merely to add to taxonomic descriptions. The only description, providing a limited understanding of the functional morphology of male genitalia in Reduviidae was given for *Rhodnius prolixus* by Davey (1959), with special reference to spermatophore production. He coined the term "Spermatophore sac" for the first time to describe a much folded membranous sac composed of the aedeagus and endophallus. Such a sac has been described as composed of two layers of cuticle bounding a blood space, the inner wall being the endophallus and outer wall the aedeagus. This spermatophore sac, therefore, was described as a sac composed of aedeagus on the exterior and the endophallus lining the lumen. The external opening of the spermatophore sac through which the spermatophore is finally released was named by Davey (1959) as the phallotreme meaning gonopore (GP) corresponding to the secondary gonophore of Lent and Jurberg (1978).

The taxonomic value of the phallus of Reduviidae has been highlighted by Davis (1966), Lent and Jurberg (1966, 1978 & 1980), Popov (1971) and Wygodzinsky and Lent(1980). While the male genitalia was considered useful to taxonomy only at the suborder level by Popov (1971), Cobben (1978) believes that they provide the strongest evidence on macroevolution, when examined at all levels within each group.

Material and Method

The male genitalia of various species of assassin bugs have been studied from dried and preserved specimens. The genital segments were severed and boiled in 5% potassium hydroxide solution for 5 minutes and then washed in dilute acetic acid and stored in glycerine. These stored materials were dissected, cleared in clove oil and mounted in polyvinyl lactophenol. Complete expansion of the invaginated endosomal structures can be achieved by applying gentle pressure to the abdomen of live, sexually active males and the evaginated expanded endosoma can be severed.

Results and Discussion

The aedeagus is a highly complicated, extensible chitinous sac of the intromittent organ, enclosed within the inner capsule of the pygophore. The pygophore is heavily sclerotised, both ventrally and mid-dorsally, but for a narrow membranous strip at the anterior border. It is

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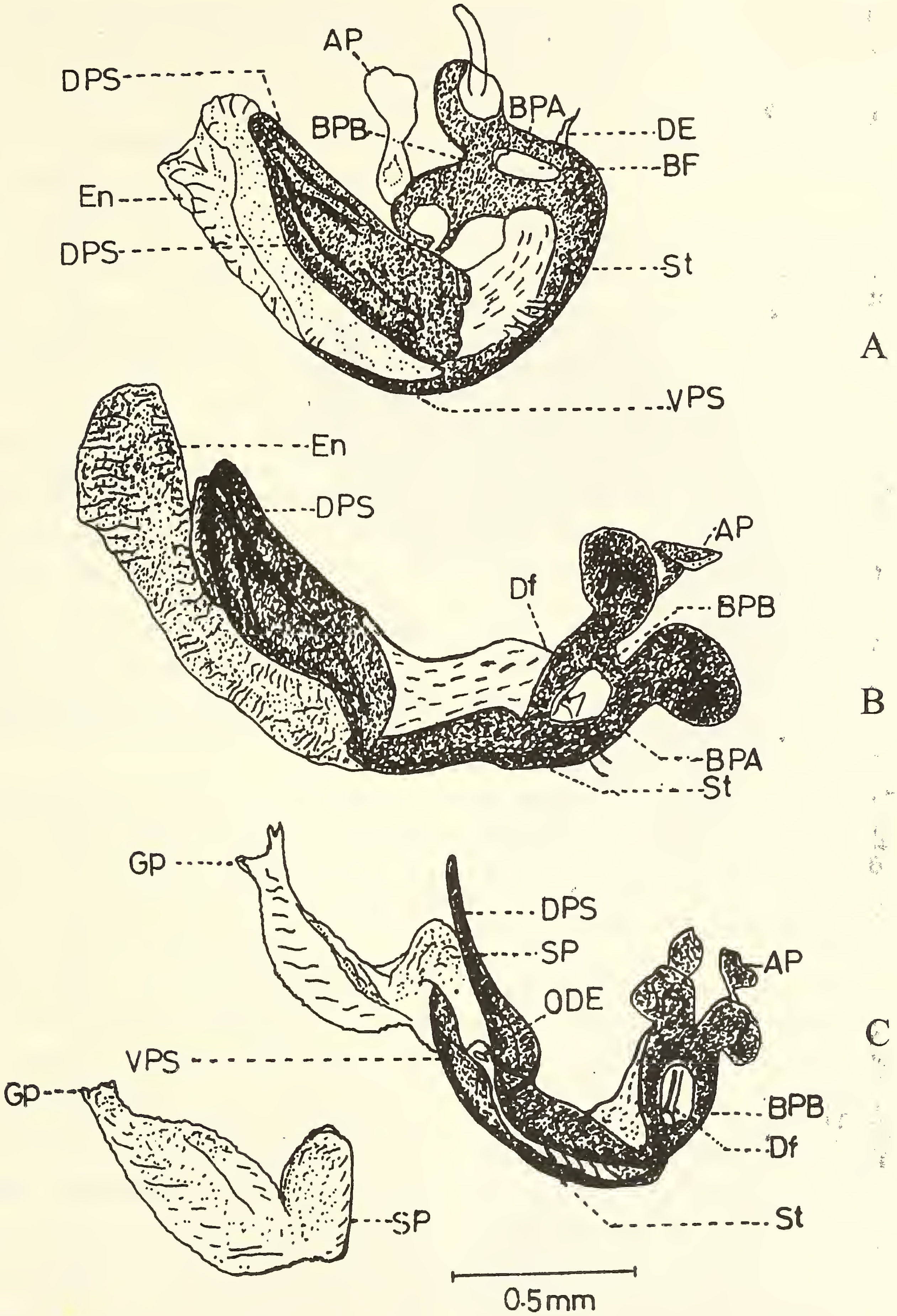
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Fig. 1: A-D. Intromittent organ in action; A: *Bardensanes sericenotatus*; B: *Oncocephalus klugii*; C: *Diaditus errabundus*.

AP: Apodemes, BF: Basal Plate Foramen, BPA: Basal Plate Arm, BPB: Basal Plate Bridge, DE: Ductus ejaculatorius, Df: Ductifer, DPS: Dorsal Phallic Sclerite, En: Endosoma, GP: Gonopore, ODE: Opening of Ductus ejaculatorius, SP: Spermatophore Pouch, St: Strut, VPS: Ventral Phallic Sclerite.

highly membranous, and is in turn covered by the proctiger. Posteriorly, the membranous part becomes sclerotised into a vertically hanging suspensory plate on either side, leaving a narrow longitudinal slit in the middle to allow the enclosed aedeagus to emerge at the time of copulation.

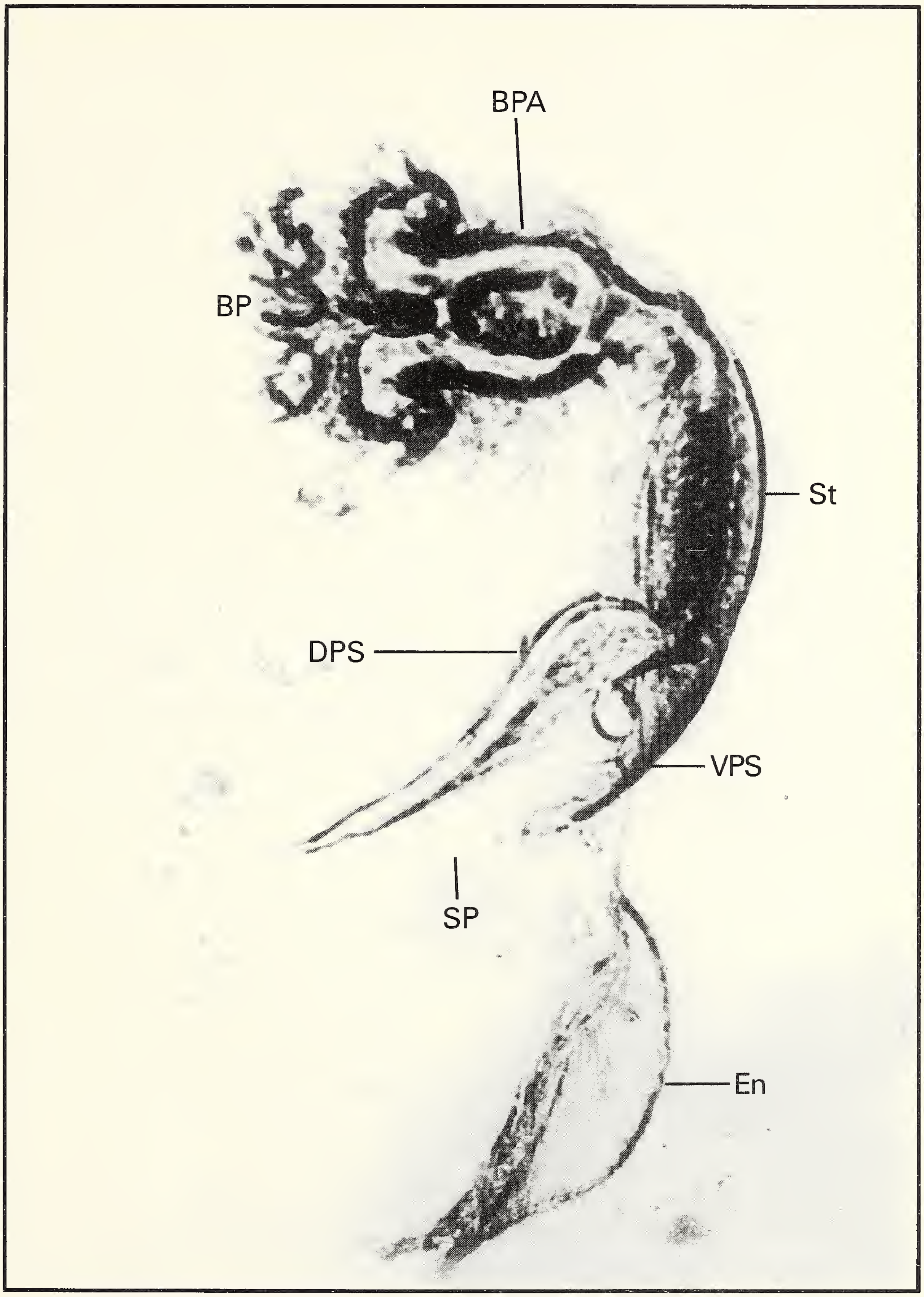
The intromittent organ in Reduviidae has been described as the basal plate and the aedeagus, since the former plays a crucial role in conveying the sperm. It catapults the aedeagus in the process of transmission of spermatophore, to lodge the same in the bursa copulatrix. Therefore, it is considered a part of the intromittent organ. It is consistently provided with two powerful arms, each arm terminating in the form of a disk that supports the apodemes (AP) bearing the tendons of all the extensor muscles that are involved in the catapulting mechanism, and a strut that hinges with the aedeagus dorsally. The strut normally remains concealed by the aedeagus. In the resting position both arms (BPA) lie on either side of it, in close proximity. Both arms may or may not be connected by a cross bar — the bridge (BPB). When the bridge is present, it establishes a fossa — the basal plate foramen (BF). In the absence of a bridge, the basal plate remains a Y-shaped structure. The ductus ejaculatorius (DE) enters the intromittent organ at the base of the strut (St) and then runs through the groove, throughout its length, to open into the spermatophore pouch (SP) that develops at the junction of the aedeagus and the basal plate.

Recognition of various structures of the reduviid phallus and description of their variations are most complicated, according to Kumar (1962). By his studies on the male genitalia of many reduviids, he has recognised three types of endosomal sclerites, corresponding to the "Phannaries" of Villiers (1948). The dorsal phallic sclerite has been described by him as the basal plate strut. The bulbus ejaculatorius as the stalk of the basal plate sac and the dorsal surface of the phallotheca was recognised as the ventral surface. While all the other workers, including Villiers (1948), Kumar (1962), Matsuda (1976), Cobben (1965, 1978), Giacchi (1969), Popov (1971), Lent and Jurberg (1966, 1978, 1980), Dupuis (1955, 1970) and Wygodzinsky and Lent (1980) described the endosoma as a bipartite structure, comprising of the conjunctiva and the vesica, Davis (1966) emphasized that the endosoma is an eversible, erectile tube, not divisible into conjunctiva and vesica. In that respect, Davis (1966) is more correct in describing a generalised type of reduviid phallus and his emphatic declaration is confirmed by the present observation.

In the case of Harpactorinae, the endotheca is highly extensive and the pressure required to expel the endotheca in the act of copulation will be much more than in other species, especially of the subfamilies Emesinae and Stenopodainae in which the foramen is narrow. Here, the endotheca is less folded and more anteriorly located due to the forward extension of the strut of the basal plate, and the spermatophore pouch is obviously located at the basidorsal area of the endotheca.

In Stenopodainae and Saicinae, the extension of the basal plate strut at the expense of the ventral phallic sclerite (VPS) has caused the shifting of the dorsal phallic sclerite (DPS) far anterior to the basal plate foramen and invariably hinged with the basal plate strut, a little behind its apex. The ductus ejaculatorius, in turn, is distended throughout the length of the basal plate groove to open into the spermatophore pouch, which is invariably located in all species at the site where the dorsal phallic sclerite is hinged to the strut. In all cases, the endophallus remains considerably shorter, with least foldings. Therefore, it is reasonable to suggest that the extent of development of the basal plate strut and its fusion with the considerably abbreviated VPS could be correlated with the simplication of the endophallus. In Stenopodainae, in all the species examined, including *Bardesanes sericenotatus, Oncocephalus klugii,* and *Diaditus errabundus* (Fig. 1C), the bridge

Ravichandran, G. *et al.*: Intromittent organs of assassin bugs PLATE 1



Intromittent organ of Reduviid assassin bugs.
BP: Basal Plate, BPA: Basal Plate Arm, DPS: Dorsal Phallic Sclerite, SP: Spermatophore Pouch, St: Strut, VPS: Ventral Phallic Sclerite.

lies far behind the head and foramen. Therefore, it is considerably abbreviated.

In Emesinae and Holoptilinae, the fusion of the basal plate and intromittent organ has reached the fullest extent, so that it is difficult to disengage the various components even after treating in KOH for a prolonged period.

Functionally, the aedeagus could be divisible into the proximal cup-shaped phallosoma and a distal, highly elastic, distensible denticulate endosoma (En), that is withdrawn into the cup. The wall of the phallosoma cup has characteristic sclerotisation that appears to be species-specific and the dorsal wall of the cup is invariably much sclerotised. The sclerotised dorsal wall is termed as the dorsal phallic sclerite (DPS) that articulates with the strut of the basal plate. It is at this point of articulation that the sperms from the ductus ejaculatorius enter the pouch of the endotheca into which the spermatophore capsule is moulded. At repose, the aedeagus at its junction with the strut of the basal plate turns back and lies on its dorsal side, with the dorsal phallic sclerites closely approximating the inner surface of the basal plate strut. In this position the DPS and VPS remain opposed to each other, like the beak of a bird, the VPS lying dorsal to the DPS, often flanked by the two wings of the latter. In this position, the endosoma has its exterior opening directed anteriorly closely shielded by both DPS and VPS.

The endosoma that develops from the rim of the cup of the phallosoma remains highly folded and variously sclerotised with extensive denticulate armature. When it remains enclosed within the cup, it has its basidorsal region folded in the form of a pouch, into which the ductus ejaculatorius conveys its spermatozoa and accessory gland secretion, and the pouch provides the mould for the formation of the spermatophore capsule. Dorsally, the pouch presses against the inner surface of the DPS, and ventrally against the rest of the endothecal wall, while basally it communicates with the lumen of the endotheca itself.

At repose, the mouth of the pouch lies opposed to the junction of the basal plate strut and the DPS at which the ductus ejaculatorius opens and spermatophore is formed within this pouch. At the time of copulation, when the protractor muscles of the basal plate contract, the arms of the basal plate are pulled back, causing the strut to exert a torsion that catapults the aedeagus outward from its original reverse position. This is followed by pushing of the endotheca outward. Further, this tilting causes the basidorsal pouch or spermathecal pouch of the endotheca to rotate at an angle of 180°, so that the mouth of the pouch lies in a straight line with the lumen of the endotheca, and the spermatophore is released to be trans-ported further through the endosomal tube and lodged inside the bursa copulatrix. Clearly, the initial catapulting of the aedeagus results from the tilting of the basal plate, brought about by its extrinsic muscles and the extension of the endotheca is further brought about by the haemocoelomic fluid pressure, through the basal plate foramen. The endotheca is guided into the gonopore of the female by the pygophore spine that assumes a more vertical position, consequent to the tilting of the pygophore capsule.

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BEE VISITATION AND POD SETTING IN *BRASSICA CAMPESTRIS* L.[1]

NARESH MAHINDRU, GURDIP SINGH AND G.S. GREWAL[2]

(*With two text-figures*)

Key words: Bee visitation, *Brassica campestris,* pod setting.

Studies were conducted on visitation behaviour of *Apis mellifera* L., *A. dorsata* F. and *A. florea* F. and number of *A. mellifera* visits on pod setting on BSH-1 variety of *Brassica campestris* L. var. brown sarson at Ludhiana during 1989-90. *A. dorsata* had longer active hours among the three bee species. *A. florea, A. dorsata* and *A. mellifera* visited 6.05, 12.89 and 17.06 flowers of this crop per minute, respectively. Single, double and multiple visits by *A. mellifera* resulted in 45.7, 72.5 and 81.6% pod setting.

INTRODUCTION

Brassica crops were grown in an area of 5 x 10^6 ha in India during 1989-90 with a production of 4.1 x 10^6 tonnes (Anon., 1990-91). *Brassica campestris* L. var. brown sarson is a cross-pollinated crop. Mahindru (1990) reported four species of bees viz. *Apis dorsata* F., *A. florea* F., *A. mellifera* L. and *Andrena* sp. associated with this crop at Ludhiana. Intensive pollination of this crop by *A. mellifera* resulted in the increase of pod setting by 29.3%, number of pods by 21.9%, seed germination by 2.85%, and oil content by 1.28% over natural pollination. In view of the benefits obtained by cross pollination of this crop by *A. mellifera,* it was considered desirable to study the visitation behaviour of important pollinating bees associated with brown sarson and number of *A. mellifera* visits on pod setting, as there is considerable scope of increasing the yield of this crop with the help of insect pollinators. The results are reported in this paper.

MATERIAL AND METHODS

Studies on visitation behaviour of important pollinating bees of *B. campestris* L. var. brown sarson were carried out at the Entomological Research Farm, Punjab Agricultural University, Ludhiana (30°-55° 'N Lat. 75°-51° E long. 247 metres above msl) and other fields around Ludhiana during 1989-90 on BSH-1 variety of brown sarson.

Population of *A. mellifera, A. dorsata* and *A. florea* were counted at hourly intervals, starting from 0900 to 1700 hrs on five clear, calm days by using the method of Linsley *et al.* (1952). For this purpose 10 sq. m (3.16 x 3.16 m) area was marked at random in the field with sticks. The area was divided into four subplots. Observations on all the sub-plots were made by moving anticlock-wise. The number of bees counted in all the four sub-plots were then added to work out their total number. The total duration for which these bees worked in the field was also recorded separately for each species. To ascertain the number of flowers visited per minute, individual bees were followed in the field for the maximum possible time. The number of flowers visited in one minute was then worked out. The average figures were calculated on the basis of observations recorded for 10 different foragers of the same species.

The relationship between bee visit and pod setting was studied by bagging flowers when they were yet to open and *A. mellifera* had not yet started visiting them. Next day, the bags were removed from the flowers and number of

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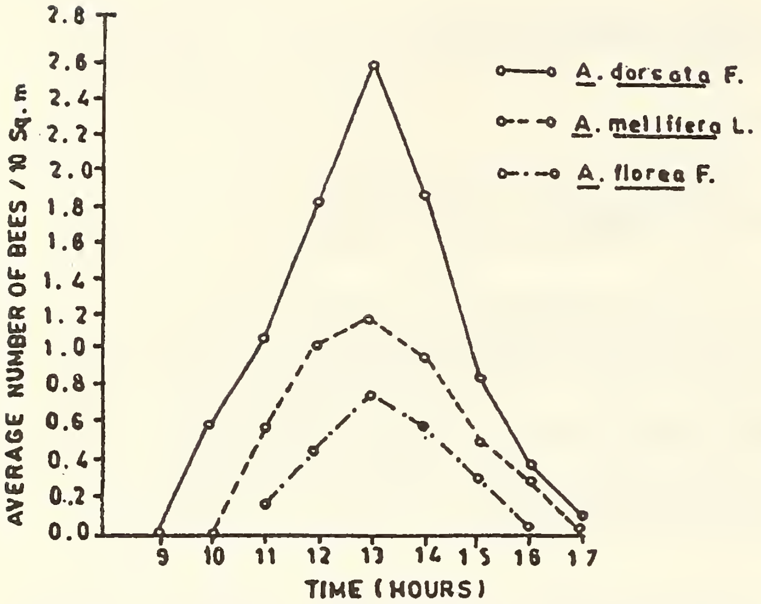

Fig. 1: Mean bee visitation at different hours of the day

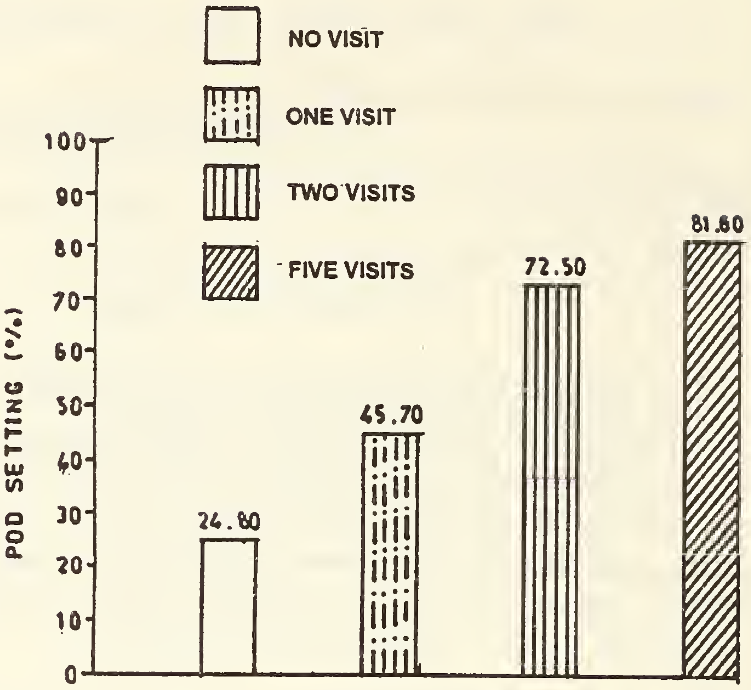

Fig. 2: Effect of number of *A. mellifera* visits on pod setting

A. mellifera visits were counted i.e. 1.2 and 5 per flower were allowed. Pod setting was observed after one week. Pod setting in 'control' flowers was also noted where no bee visit was allowed. These observations were repeated on five different dates viz. Jan. 26 , Feb. 2, Feb. 11, Feb. 21 and Feb. 28, 1989.

RESULTS AND DISCUSSION

Bee visitation: It was observed that *A. dorsata* visited the crop between 9-17 h, *A. mellifera* between 10-17 h and *A. florea* between 11-16 h. The data further revealed that the number of all the three species of bees present in the field increased between 12-14 h with peak activity at 13 h (Fig. 1). Kakkar (1981) reported that activity of honeybees was higher between 12-14 h on cauliflower. Rahman (1940) found that on sarson *A. florea* began their visits after 11 h and were mostly present in the field upto 16 h. The present study on sarson revealed that all the three species of bees were present in higher numbers between 12 and 14 h with a peak at 13 h. Their number was considerably lower before 12 and after 15 h.

Number of flowers visited per minute: The average number of flowers visited per minute was observed, to assess the species' potentiality to affect cross-pollination. It was observed that *A. florea* on an average visited 6.05 flowers per minute, whereas *A. dorsata* and *A. mellifera* visited 12.89 and 17.06 flowers per minute, respectively. *A. mellifera* was found to be the most fast moving. It visited a significantly greater number of flowers per minute as compared to *A. dorsata* and *A. florea* at mean temperature 12°C.

Benedeck *et al.* (1972) reported honeybees visiting 39 rape flowers during a period of 4.4 minutes. Bhalla *et al.* (1983) noticed *A. cerana indica* visiting 10.24 flowers per minute on *B. campestris* var. sarson. Rahman (1940) reported that *A. florea* visited an average of 6.09 flowers of sarson in one minute. Our investigations revealed that *A. florea* visited the least number of flowers per minute, whereas *A. mellifera* was found to be the most efficient and quick moving pollinator.

Relationship between bee visit and pod setting : Zero, one, two and five *A. mellifera* visits per flower resulted in 24.80, 45.70, 72.50 and 81.60% pod setting, respectively (Fig. 2). It was observed that with increase in the number of bee visits per flower, there was significant increase in pod setting. Grewal (1975) reported that five bee visits per flower in *Cucurbita pepo* L. and ten bee visits per flower in *Cucumis melo* L. gave adequate fruit setting. Free (1970) reported that more than one bee visit per flower was necessary to transfer a sufficient number of pollen grains to pollinate muskmelon satisfactorily. Girish (1983) found that with the increase in bee visits from 1 to 7 per flower, the fruit setting increased significantly in *C. pepo.* The present investigation also revealed that in sarson, with increase in the bee visits of *A. mellifera* from 1 to 5, higher pod setting was achieved. The presence of an increased number of honeybees was thus more useful in sarson.

ACKNOWLEDGEMENT

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POLLINATION ECOLOGY OF *CASSIA ALATA* L. (CAESALPINIACEAE)[1]

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(*With one text-figure*)

Key words: *Cassia alata,* heteranthery, enantiostyly, carpenter bees, pollination.

Cassia alata blooms annually during October-February. The flowers are borne on typical racemes, and are yellow and devoid of nectar. They exhibit enantiostyly and heteranthery with feeding as well as pollinating anthers. In the biotope of the study area, the carpenter bees consisting of *Xylocopa latipes* and *X. pubescens* are the exclusive visitors to *C. alata.* They collect pollen by buzzing. During the vibratile movement of the visitor's body, the pollen grains are discharged from pollinating anthers on to the sides of the insect visitor's thorax and abdomen. Simultaneously, the pollen grains are also transferred to the stigmas oriented to the right or to the left. Heteranthery and enantiostyly, complemented by the buzzing behaviour of the pollinating carpenter bees, promote geitonogamy as well as xenogamy in *C. alata.*

Introduction

Buchmann (1983) gave a complete list of anthecological work on Cassia species which include *C. fasciculata, C. fistula, C. glauca, C. bacillaris, C. multijuga, C. didymobotrya, C. auriculata,* and *C. alata.* Those works not mentioned by Buchmann (1983) have been touched upon by Gottsberger and Gottsberger (1988). These studies show that pollen discharge by release of a small cloud of pollen occurs from apical pores of the anthers by vibratile behaviour of the bees collecting pollen. The genus *Cassia* is known to exhibit heteranthery and enantiostyly. Heteranthery means that the androecium of the same flower is functionally differentiated into short stamens with feeding anthers, which provide food for the pollinator, and longer stamens with pollinating anthers which provide pollen for pollinating the stigma. Enantiostyly refers to the occurrence of right-styled and left-styled flowers on the same inflorescence. This floral dimorphism has been treated as a device for enhancing outbreeding (Bahadur *et al.* 1990). However, Dulberger (1981) cautions that it need not be connected with outcrossing.

Carpenter bees are the only insects pollinating *Cassia* sp. so far studied. The bees collect pollen from feeding anthers by rapidly contracting the indirect flight muscles, thus producing strong vibrations that are transmitted directly to the anthers and indicated by audible buzzing of the bees. This vibration rapidly produces a directed stream or pollen cloud from the anther pores that primarily strikes the venter of the bee, and sometimes the pleural and dorsal areas also. During this act, the pollen from pollinating anthers situated over the dorsal side or lateral sides of the bee is discharged and deposited on the head-thorax region of the foraging bee, resulting in nototriby or pleurotriby. The stigma of the flower simultaneously strikes the pollen-laden head-thorax region of the bee.

Pijl (1954) has provided fragmentary information on the floral biology of *C. alata* in Java. He suggests that *C. alata* has a similar

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floral mechanism and is pollinated by carpenter bees. The available information on this medicinally valuable plant is highly inadequate to understand its unique form of pollination, and the information is from Java, where meteorological conditions may differ from those of India. Complete details of the floral ecology of *C. alata* are necessary for its commercial cultivation.

MATERIAL AND METHODS

Cassia alata L. is abundant in Visakhapatnam (17° 42' N and 82° 18' E). The studies were carried out in 1989 and 1990. To determine flowering phenology, ten inflorescences selected at random were tagged before the initiation of blooming and observed for the daily opening of flowers. The inflorescences were then removed to avoid recounting the next day. Tagged inflorescences were observed until they ceased flowering to obtain data on the duration of flower production and also the daily rate of flowering. Flower morphometrics were observed in detail. Daily anthesis rate was noted from ten randomly selected inflorescences marked before anthesis. Time of anther dehiscence was recorded by observing the anthers with a 10x hand lens before and after the flowers opened. Undehisced mature anthers, immersed separately in a drop of lactophenol aniline-blue were observed under the microscope, and the number of pollen grains per anther was counted to determine pollen output. Pollen production per anther was then multiplied by the number of anthers to estimate total pollen grains per flower. Structural characters of pollen grains were observed and their size was measured with a calibrated ocular micrometer. Pollen-ovule ratio was determined by dividing the number of pollen grains per flower by the number of ovules per flower. Pollen viability was tested by hand-pollination experiments using relatively fresh stigmas, and stigma receptivity by hand-pollination using relatively fresh pollen. Breeding behaviour was studied through controlled pollination. Fruit set, seed set and fecundity rates in controlled pollination were measured following the procedure described by Aluri and Subba Reddi (1994). The flower and fruit abortions were expressed in percentages.

Flower visitors were carpenter bees of two species of *Xylocopa* only. Foraging activity of these bees, their foraging behaviour, forage resource sought, pollination potential, etc. was investigated in detail. The pollen carrying capacity of the bees was also determined by counting the pollen grains obtained from body washings in aniline-blue. The duration of flower visit and flowers foraged in a unit time by the flower-visitors were noted to assess the foraging speed.

RESULTS

Flowering phenology: The plants of *C. alata* grow from new seeds every year following the first rains of the monsoon and continue to grow until late September. Then they start producing inflorescence stalks and flower buds. The mature flower buds begin to open from October through February. A plant flowers for an average period of 88 days (range 61-106).

Inflorescence phenology: The inflorescence is a typical terminal raceme. An inflorescence produces a mean number of 88 flowers (range 40-117) anthesing over an average period of 24 days (range 16-29). Each day the number of newly opened flowers of an inflorescence varies from 2-5. Flower production ceases in February, then the plants start to dry up and wither.

Flower morphology: The flowers are bisexual, showy but lack fragrance. The calyx consists of 5 sepals, each 1.5 cm long. The yellow corolla is ovate and divided into 5 petals. The clawed and imbricated petals are first involute and later become spread. Stamens are 10. The uppermost (adaxial) three stamens have sterile anthers. The remainder possess fertile anthers

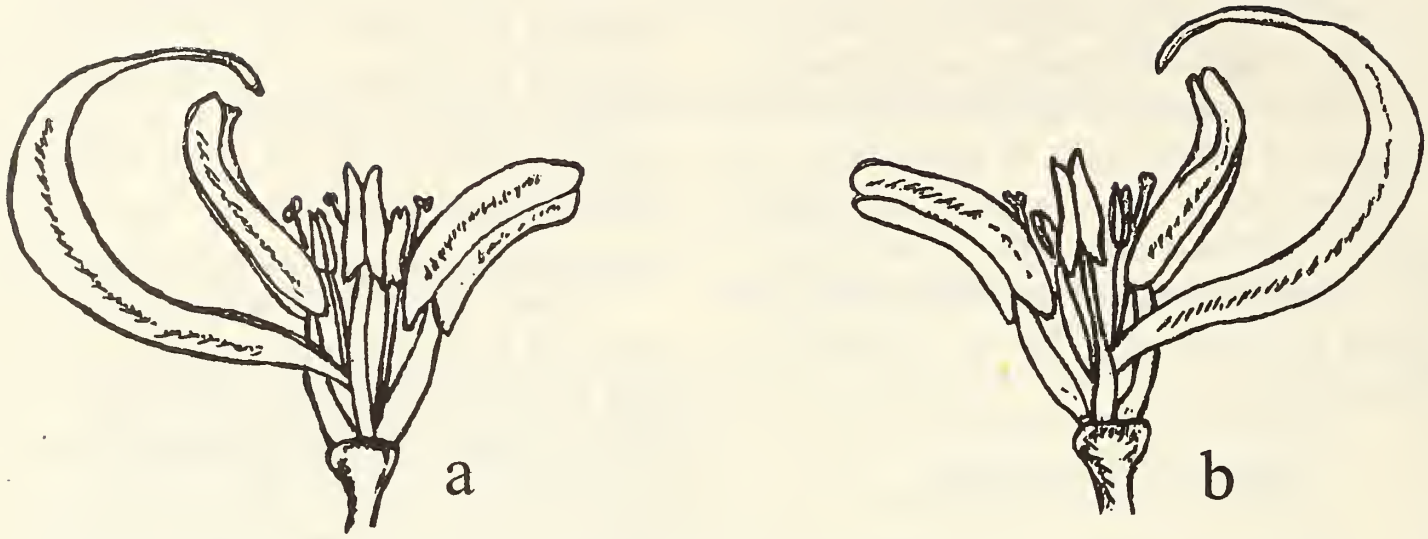

Fig. 1: Enantiostyly in *Cassia alata* L. a. Left-styled flower; b. Right-styled flower

which can be grouped into three categories. The top central group of 4 stamens have filaments 3 mm long and anthers 4 mm long. The second group composed of 2 large lateral stamens having filaments 4 mm long and anthers 10 mm long, are situated below the top central group. The anthers of this group are thick, hard, curved, tapering and slightly twisted. The third group represents one lower-most (abaxial) median stamen with a 7 mm long filament and a 5 mm long anther. The ovary has 60 ovules (range 50-63) arranged in a linear fashion. The upwardly bending sickle-shaped pistil emerges between the bases of the second group of stamens and above the median stamen of the third group. The pistil projects to the right or to the left in the flowers of the same inflorescence (Fig. 1), but without any regular pattern. The ratio of right-styled and left-styled flowers in an inflorescence is nearly 1:1. The style is terminated with a simple stigma having a cavity-like opening.

Anthesis and anther dehiscence: The flowers open daily during 0300-0400 h. Anthers dehisce by pores; a pore is formed at the apical appendage of each anther lobe. Dehiscence takes place about 3 h after anthesis. The corolla, together with stamens, falls off in 36-48 h after anthesis.

Pollen characters: Pollen grains are triangular, tricolporate, with a smooth exine. The grains are 43-51 µm in diameter. Pollen production per anther in the three categories of fertile stamens is different. It averages 32,600 (range 29,000-37,000) in the top central group of stamens. The corresponding figures for the second and the third group of stamens is 2,47,000 (range 2,10,640-2,86,000) and 22,410 (range 18,550-25,460) respectively. A few grains are sterile in all the three groups of stamens (3-5%). The pollen-ovule ratio is 9,880:1.

Pollen viability and stigma receptivity: *C. alata* pollen germinated well in 50% sugar concentration. The germination percentage obtained for fresh pollen is 90%, 24 h old pollen 68% and for 100 h old pollen 6%. The pollen viability tested through fruiting ability showed that the stigma pollinated with fresh pollen produced 84% and those with 96 h old pollen gave 20% fruiting.

The tests conducted for fruiting ability of the stigmas of different maturing periods from anthesis to the flower life up to 36 h showed that the stigma favours pollen germination and later gives fruit for 30 h. This condition of the stigma is taken as stigma receptivity period. The fruiting ability of the stigma, however, was not the same throughout the receptivity period. The percentage of fruiting obtained with fresh stigmas was 84%. With advancement in the age of the stigma, there was reduction in fruiting, it being 12% with 30 h old stigmas.

Breeding behaviour: The results of breeding tests show that the plant is not apomictic, but reproduces through xenogamy and geitonogamy. The xenogamic fruiting, seeding and fecundity values obtained were 84,100 and 84%, respectively. The agreeing values for geitonogamy were 68,100 and 68%.

Natural flower and fruit abortions: The recorded natural flower and fruiting pattern show that about half of the flowers fall off without any signs of fruit development. In the remainder, about 25% initiate fruit development and then abort. The remaining flowers ranging from 19-25% develop mature fruit. The mature fruits are largely produced at the basal part of the inflorescence.

Flower visitors: The flowers of *C. alata* are foraged exclusively by *Xylocopa pubescens* and *X. latipes*. The foraging visits of these bees are, however, significantly disproportionate. *X. latipes* made 64-70% of foraging visits while *X. pubescens* only 30-36%. But the two species were equally mobile. Both foraged 13 flowers (range 7-20) in one minute and spent 2-4 seconds at a flower. The bees usually foraged on fresh flowers and occasionally on day-old flowers. The foraging speed of the two species was greater on sunny days compared to cloudy days. On sunny days, the bees started foraging at 0800 h and stopped at 1600 h. The activity was more brisk around noon. The foraging schedule of the bees was delayed by two hours and stopped early by an hour on cloudy days.

Foraging behaviour: The yellow corolla appears to attract and direct carpenter bees to the pollen source in the flower. On approaching the flower, the bee lands on the top central and the third group of stamens situated in the middle of the flower. While landing, it curls its body over the anthers and produces a high-pitched buzzing sound which is quite different from the flight sound. The head and thorax of the buzzing bee are now covered over by the upper involute petals, while the lower petals are pressed downward by the weight of the bee. The bee vibrates its body and collects pollen from the top central and third group of anthers. A buzzing sound is heard and the pollen is deposited all over the ventral side of the bee, where it is greatly accessible for grooming and for subsequent ingestion. Added to this, the stigma does not make contact with the ventral side of the bee. The four stamens of the top central group and the single stamen of the third group constitute the feeding anthers. The second group, with larger stamens oriented laterally, discharge pollen onto the sides of the thorax and abdomen of the bee. Washings of the thorax revealed 180 to 325 pollen grains, while those of the abdomen area showed 180-260 grains. The pollen deposited in this area may be totally inaccessible for grooming or for ingestion. The stigma of the right- and left-styled flowers touches the dorsal side of the thorax and the abdomen, where pollen from lateral anthers is deposited. The second category of stamens, the lateral ones, thus constitute the pollinating anthers.

DISCUSSION

As early as 1909, Burkill considered *Xylocopa* sp. to be the most important flower-visiting insects in the plains of tropical India, and largely responsible for the pollination of sunhemp, Indian pulses and Cassias. From other tropical regions *Xylocopa* sp. have been reported as pollinators of several *Cassia* species. Knuth (1906) reported that in South Asia, the main pollinators of *Cassia* spp. with large and medium sized flowers are *X. latipes* and *X. aestuans*. Pijl (1954) describes three large-flowered tropical species of *Cassia* with typical *Xylocopa* flowers; one of these species is *Cassia alata*. We observed that the flowers of *C. alata* in Visakhapatnam are visited and pollinated exclusively by *X. latipes* and *X. pubescens*.

C. alata flowers are nectarless, and the floral reward is only pollen. The male carpenter bees do not forage for pollen (Buchmann, 1983). Then successful pollination in *C. alata* should result from the activity of female carpenter bees. The captured pollinators in the present study were female.

On the basis of P/O ratio (9880:1), *C. alata* may be treated as highly xenogamous (Cruden, 1977). However, breeding experiments revealed that both xenogamy and geitonogamy operate with equal success in seed formation. Cruden and Jensen (1979) suggest that P/O ratios may reflect pollination efficiency, and the lower P/O ratio makes more efficient delivery of pollen. Thus, in *C. alata* the high P/O ratio may indicate inefficient delivery of pollen.

However, the 100% seed set and the nototribic and/or pleurotribic transfer of pollen suggest that the pollination mechanism in *C. alata* is efficient. The high pollen production which resulted in the high P/O ratio compensates the pollen wastage/loss from pollinator feeding. Further, the small size of the stigma, compared to the area of pollen spread on the body of the bee, may also necessitate the production of large amounts of pollen. These interpretations agree with those of Dulberger (1981) who also found unusually high P/O in *C. didymobotrya* and *C. auriculata.*

Flower function and bee behaviour suggest that geitonogamy cannot be eliminated. When the bee lands on an inflorescence, it visits all the fresh flowers that range from 2-5. In every visit of the bee, its dorsal thorax or abdomen, powdered with pollen grains makes contact with the stigma. Then, the pollen grains are transferred to the stigma. The pollen thus transferred may be geitonogamous or xenogamous.

Contrary to the present observations, Pijl (1954) observed in Java that isolated plants of *C. alata* are sterile. He writes that the flowers of an old specimen of *C. alata* have been setting fruit to almost 100%. After clearing the surrounding vegetation in the whole field no fruit was formed. As soon as the neighbouring young plant, which had also been spared, started flowering, the inflorescence of the first one produced fruits again. Perhaps, *C. alata* may be having different races in different geographical regions, with differing breeding systems.

Heteranthery and enantiostyly in *Cassia* species might be taken as a device for promoting outcrossing (Bahadur *et al.* 1990). Efficacy of this strategy in promoting outcrossing in *C. alata* is poor. The flowers have their pollinating anthers oriented on both sides of the flower and the stigma, whether in R and L flowers, can invariably receive pollen of the two pollinating anthers. Since the flowers are compatible to both geitonogamous and xenogamous pollen, and the pollinator visits all the 2-5 flowers that open in a day, the situation may enhance geitonogamous pollination, irrespective of the presence of enantiostyly. However, considering the flight pattern of carpenter bees which involve interplant and interpopulation flights, it is likely that xenogamous pollination is also promoted, though the incidence of such pollination relative to geitonogamy can only be assessed through pollen tagging tests. Dulberger (1981), while interpreting the functions of various morphological characters of *C. auriculata* and *C. didymobotrya,* concluded that the main function of enantiostyly need not be connected with outcrossing. He says that its primary role may be that of clearing access of the insect to the feeding anthers, at the same time protecting the female parts from injury by insect vibrations. Possible injury may be prevented by the presentation of stigma and style from the median plane of symmetry, so that it comes into contact with the back or side of the insect rather than its ventral part. As revealed by the extensive studies of vibratile pollination (Buchmann, 1983), the intensity of buzzing increases with the size of the insect. Carpenter bees are the giants of the bee world (Meeuse 1961) and are to be treated as powerful buzzers (Roubik, 1989). Therefore, it is reasonable to assume that in flowers exhibiting the buzz-pollination syndrome discussed at length by Buchmann (1983), the style deflections may have evolved together with changes in stamen orientation and a division of androecium into upper and lower anthers. It may be noted that the female part deflected away from the flower centre is the whole carpel. Enantiostyly might be a safeguarding device from the damage that may result from the weight of the pollinator and intensity of its vibrations.

Gottsberger and Gottsberger (1988) state that in their study on the flower adaptation and evolution of the Cassinae in relation to pollination events, there was often no real contact of the bee body with the stigma and/or anther openings, but that there occurred close approximation. Then, to explain the deposition of pollen on the stigma, they relied on the concept of Corbet *et al.* (1982) that electrostatic forces play an important role in pollen transfer via insects. Electrostatic potentials enable pollen to jump from anther to bee and from bee to stigma. Even if there is direct contact, as seen in the present study of *C. alata*, electrostatic forces are necessary to push or pull pollen into the hollow style tip wherein the stigmatic surface is located. As stated by Buchmann (1983) and Gottsberger and Gottsberger (1988), there would be a lot of pollen dispersal and loss into the air but for the electrostatic field around a visiting bee. In the absence of electrostatic field around the pollination vector, the cloud of pollen released during vibration should become airborne and pollen trapping in the atmosphere should reveal high concentrations. However, pollen trapping in the ambient air has revealed low concentrations of *Cassia* pollen. The probable importance of electrostatic forces in buzz-pollination has also been recognised by Buchmann (1978) and Buchmann and Hurley (1978).

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■ ■ ■

NEW DESCRIPTIONS

NEW SPECIES OF *SILESIS* CANDEZE (COLEOPTERA, ELATERIDAE: ADRASTINAE) FROM INDIA[1]

Punam Garg, M.S. Saini and V. Vasu[2]

(*With four text-figures*)

Key words: New species, *Silesis* Candeze, Elateridae, India.

Four new species of *Silesis* Candeze have been described and illustrated: *S. vatsi, S. longicarinatus, S. brevicarinatus* and *S. ecarinatus.* While running them through Platia and Schimmel's (1991) key, these species come close to *S. lebischi.* The characters distinguishing *S. vatsi* from its allied species are given in the text. In the four new species, antennal segment 2 is shorter than 3 (equal in *S. lebischi*), which distinguishes them from *S. lebischi.*

Introduction

Candeze (1863) erected genus *Silesis* which now includes 52 species from India. The Indian fauna of this genus have been studied by Fleutiaux (1940, 1947), Ohira (1969), Ohira and Becker (1971, 1974), Platia and Schimmel (1991, 1993) and Vats and Chauhan (1993). We are adding 4 new species from the Indian subcontinent. The features separating them from their closely related species are discussed. The genus *Silesis* Candeze is characterised by: Supra-antennary crest oblique, not united in middle; frons truncate in front; tarsi with 4th segment lamellate; aedeagus longer than parameres; parameres simple, with or without subapical processes. Instead of giving a revised key to the species, a new section is inserted in Platia and Schimmel's (1991) key by replacing the couplet 61, as follows:

61. Antennal segments 2 & 3 equal 61a
— Antennal segments 2 & 3 not equal 61b
61a. Pronotum broader than long, frons flat, with hexagonal punctation .... *S. vatsi* sp. nov.
— Pronotum longer than broad, frons convex, with umbilicate punctation .... *S. lebischi* Platia & Schimmel
61b. Antennal segment 2 shorter than 3 ....61c
— Antennal segment 2 longer than 3 62
61c. Prosternal spine margined between mesocoxae 61d
— Prosternal spine margined entirely .... *S. ecarinatus* sp. nov.
61d. Carina of posterior pronotal angles reaching middle of pronotum; metabasitarsus longer than following 2 joints combined; elytra 3.2x prothorax length; antennal segments 2-4 as 3:4:6 .... *S. longicarinatus* sp. nov.
— Carina of posterior pronotal angles not reaching middle of pronotum; metabasitarsus equal to following 2 joints combined; elytra 2.8x prothorax length; antennal segments 2-4 as 1:2:3 .... *S. brevicarinatus* sp. nov.

The type material of the new species will be deposited at Pusa National Collections, Indian Agricultural Research Institute, New Delhi, after completion of the project.

Silesis vatsi sp. nov
(Fig. 1)

Colour: Body black. Antennae and legs ferruginous.

Measurements: Body: length 5 mm, width 1.35 mm; head: length 0.62 mm, width 0.75 mm; antenna 2 mm, 2nd segment 0.1 mm, 3rd segment 0.1 mm, 4th segment 0.2 mm, last

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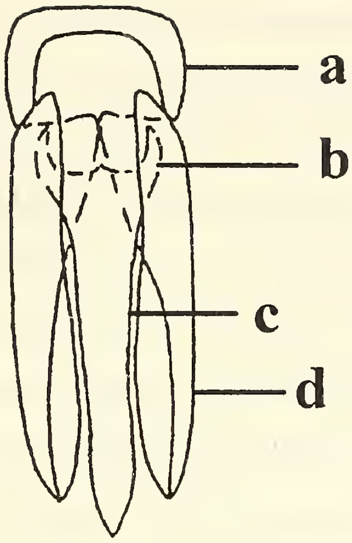

Fig. 1: Male genitalia of *Silesis vatsi*
a. Phallobase; b. Furca; c. Aedeagus; d. Paramere

segment 0.25 mm; thorax: length 1.15 mm, width 1.35 mm; elytra 3 mm.

Structure: Body width more than 0.25 times its length. Head flat, broader than long as 6:5, antenna extending slightly beyond posterior angle of pronotum, segment 3 equal to 2 but shorter than 4 as 1:2. Mandible dentate. Pronotum convex, broader than long as 9:8, lateral sides parallel, posterior margin furrowed; posterior angle pointed, carinate, carina reaching middle of pronotum; prosternal spine pointed, margin entire, gradually declined from its main axis at 10°, gradually narrowing from base; lateral carina entire. Metasternum ecarinate, truncate between mesocoxae. Scutellum flat, longer than broad as 6:4, anterior margin truncate with central protuberance, posterior margin subacute. Elytra convex, 2.6 times prothorax length, each subacute at extremity; striae distinct. Last sternite flat. Metabasitarsus longer than following 2 joints combined as 3:2.

Sculpture: Head with simple, dense, moderate, hexagonal punctation; pronotum punctate like head; propleurae with simple, sparse, elongated punctation; prosternum with simple, moderate, rounded punctation; elytral striae with deep, distinct, dense, rounded punctation; interstriae with simple, dense, rounded punctation.

Pubescence: Body covered with simple, dense, slanting yellowish brown pubescence.

Male genitalia: (Fig. 1). Phallobase with straight anterior margin; parameres without subapical processes; aedeagus longer than parameres, conical at apex; furcae not reaching anterior margin of parameres.

Material examined: *Holotype*: Male, Sikkim, Namchi, 1650 m, 16.v.1993, under light, Coll. Punam. *Paratype*: 1 male with same data as holotype.

Distribution: INDIA: Sikkim.

Diagnostic combinations: This species can be separated from its allied species *S. lebischi* as: pronotum broader than long (longer than broad in *lebischi*), frons flat with hexagonal punctation (convex with umbilicate punctation in *lebischi*).

Etymology: The species is named in honour of Prof. L.K. Vats, Kurukshetra University, Kurukshetra.

Silesis longicarinatus sp. nov.
(Fig. 2)

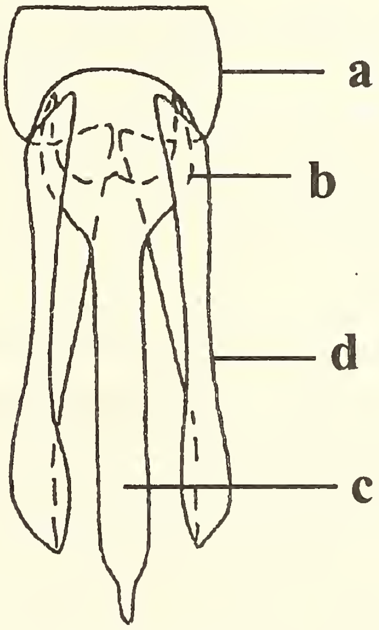

Fig. 2: Male genitalia of *S. longicarinatus*
a. Phallobase; b. Furca; c. Aedeagus; d. Paramere

Colour: Body black. Antenna and legs ferruginous.

Measurements: Body: length 6 mm, width

1.25 mm; head: length 0.5 mm, width 0.75 mm; antenna 2.5 mm, 2nd segment 0.15 mm, 3rd segment 0.2 mm, 4th segment 0.3 mm, last segment 0.35 mm; thorax: length 1.25 mm, width 1.25 mm; elytra 4 mm.

Structure: Body width less than 0.25 times its length. Head flat, broader than long as 3:2; antenna extending beyond posterior angle of pronotum, segment 3 longer than 2 as 4:3 but shorter than 4 as 2:3. Mandible dentate. Pronotum convex, as long as broad, lateral sides parallel, posterior margin furrowed, posterior angle pointed, carinate, carina reaching middle of pronotum; prosternal spine pointed, margined between mesocoxae, gradually declined from its main axis at 30°, abruptly narrowing from base; lateral carina entire. Metasternum ecarinate, truncate between mesocoxae. Scutellum flat, longer than broad as 4:3, anterior margin truncate with median protuberance, posterior margin arcuate. Elytra convex, 3.2 times prothorax length, each subacute at extremity; striae distinct. Last sternite flat. Metabasitarsus longer than following 2 joints combined as 4:3.

Sculpture: Head with simple, dense, small, hexagonal punctation; pronotum punctate like head; propleurae with simple, sparse, rounded punctation; prosternum punctate like propleurae; elytral striae with deep, distinct, oval punctation; interstriae with simple, sparse, fine, inconspicuous punctation.

Pubescence: Body covered with simple, dense, slanting yellowish brown pubescence.

Male genitalia: (Fig. 2). Phallobase broad with straight anterior margin; parameres without subapical processes; aedeagus longer than parameres, tubular, posteriorly tapering to nipple-like apex; furcae extending beyond anterior margin of parameres.

Material examined: *Holotype*: Male, West Bengal, Mirik, 1700 m, 11.v.1993, on forest vegetation, Coll. V. Vasu. *Paratype*: 1 female, with same data as holotype.

Distribution: INDIA: West Bengal.

Diagnostic combinations: On the basis of the following significant characters, *S. longicarinatus* can be separated from its allied species *S. brevicarinatus*; carina on posterior angles of prothorax long, reaching middle of pronotum (short, not reaching middle in *brevicarinatus*) metabasitarsus longer than following joints combined (equal in *brevicarinatus*) elytra 3.2 x prothorax length (2.8 times in *brevicarinatus* antennal segments 2-4 as 3:4:6 (as 1:2:3 in *brevicarinatus*).

Etymology: The species is named after long carina on posterior angles of the prothorax.

Silesis brevicarinatus sp. nov.

(Fig. 3)

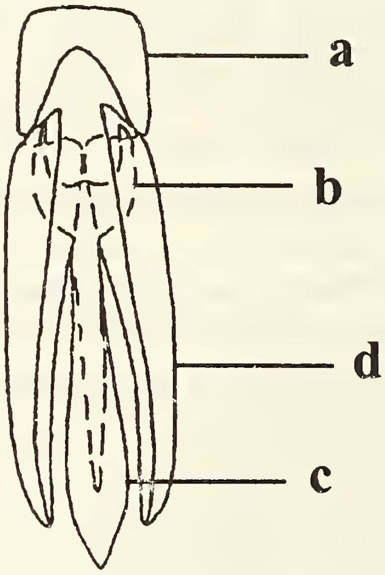

Fig. 3: Male genitalia of *S. brevicarinatus*
a. Phallobase; b. Furca; c. Aedeagus; d. Paramere

Colour: Body black. Antenna and legs ferruginous.

Measurements: Body: length 5.5 mm, width 1.25 mm; head: length 0.5 mm, width 0.75 mm; antenna 2.25 mm, 2nd segment 0.1 mm, 3rd segment 0.2 mm, 4th segment 0.3 mm, last segment 0.3 mm; thorax: length 1.25 mm, width 1.25 mm; elytra 3.5 mm.

Structure: Body width less than 0.25 times its length. Head flat, broader than long as 3:2; antenna extending beyond posterior angle of pronotum, segment 3 longer than 2 as 2:1 but shorter than 4 as 2:3. Mandible dentate. Pronotum convex, as long as broad, lateral sides parallel, posterior margin furrowed; posterior angle rounded, carinate, carina short, not reaching middle of pronotum; prosternal spine rounded, margined between mesocoxae, abruptly declining from its main axis at 20°, abruptly narrowing from base; lateral carina entire. Metasternum ecarinate, truncate between mesocoxae. Scutellum flat, ecarinate, longer than broad as 6:5, anterior margin truncate, with median protuberance, posterior margin arcuately pointed. Elytra convex, 2.8 times prothorax length, each subacute at extremity; striae distinct. Last sternite flat. Metabasitarsus equal to following 2 joints combined.

Sculpture: Head with simple, dense, moderate, hexagonal punctation; pronotum punctate like head; propleurae with simple, sparse, elongated punctation; prosternum with simple, sparse, fine punctation; elytral striae with deep, distinct, rounded punctation; interstriae with simple, dense, elongated punctation.

Pubescence: Body covered with simple, dense, slanting, yellowish brown pubescence.

Male genitalia: (Fig. 3). Phallobase with straight anterior margin; parameres without subapical processes; aedeagus longer than parameres, narrow at base, posteriorly forming conical apex; furcae not reaching anterior margin of parameres.

Material examined: *Holotype*: Male, Sikkim, Gangtok, 1500 m, 13.v.1993, on the leaf of wild *Rosa* sp., Coll. Punam. *Paratype*: 1 female with same data as holotype.

Distribution: INDIA: Sikkim.

Diagnostic combinations: The characters distinguishing *S. brevicarinatus* from its allied species *S. longicarinatus* are discussed under the latter.

Etymology: The species name pertains to the short carina on posterior angles of the prothorax.

Silesis ecarinatus sp. nov.
(Fig. 4)

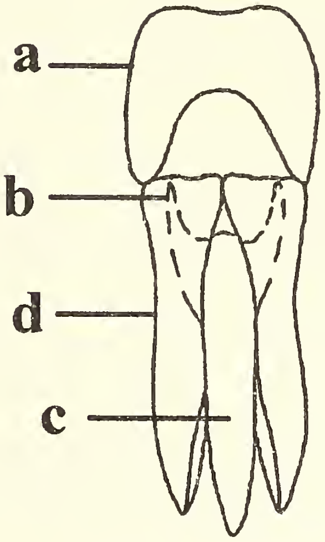

Fig. 4: Male genitalia of *S. ecarinatus*
a. Phallobase; b. Furca; c. Aedeagus; d. Paramere

Colour: Body fuscous except blackish head and ferruginous antenna and legs.

Measurements: Body: length 5 mm, width 1.25 mm; head: length 0.5 mm, width 0.65 mm; antenna 2.12 mm, 2nd segment 0.1 mm, 3rd segment 0.2 mm, 4th segment 0.2 mm, last segment 0.25 mm; thorax: length 1 mm, width 1.25 mm; elytra 3 mm.

Structure: Body width equal to 0.25 times its length. Head convex, broader than long as 5:4; antenna not reaching posterior angle of pronotum, segment 3 longer than 2 as 2:1 but equal to 4. Mandible dentate. Pronotum strongly convex, posterior margin furrowed; posterior angle pointed, carinate, carina not reaching middle of pronotum; prosternal spine pointed, margin entire, gradually declining from its main axis at 15°, abruptly narrowing from base; lateral carina entire. Metasternum ecarinate, truncate between mesocoxae. Scutellum flat, ecarinate, longer than broad as 5:4, anterior margin straight with median protuberance, posterior margin pointed. Elytra convex, 3 times the length of prothorax, each subacute at extremity; striae distinct. Last sternite flat. Metabasitarsus equal to following 2 joints combined.

Sculpture: Head with simple, dense, small, rounded punctation, pronotum punctate like head; propleurae with simple, sparse, rounded punctation; prosternum punctate like propleurae; elytral striae with deep, distinct, oval punctation; interstriae with dense, fine punctation.

Pubescence: Body covered with simple, dense, slanting, yellowish brown pubescence.

Male genitalia: (Fig. 4). Phallobase with slightly concave anterior margin; parameres without subapical processes; aedeagus slightly longer than parameres, tubular, rounded at apex; furcae not reaching anterior margin of parameres.

Material examined: *Holotype*: Male, Arunachal Pradesh, Dirang, 1500 m, 11.v.1992, under light, Coll. V. Vasu. *Paratypes*: 1 male, 1 female with same data as holotype.

Distribution: INDIA: Arunachal Pradesh.

Diagnostic combinations: *S. ecarinatus* is unique in having antennal segment 2 shorter than 3; prosternal spine margin entire, head broader than long, antenna not reaching posterior angles of prothorax; scutellum ecarinate and metabasitarsus equal to following joints combined.

Etymology: The species name is derived from its ecarinate scutellum.

ACKNOWLEDGEMENT

We thank Prof. L.K. Vats, Chairman, Department of Zoology, Kurukshetra University, Kurukshetra for his valuable suggestions and permission to use material and literature.

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A NEW SPECIES OF *IPHIAULAX* FOERSTER (HYMENOPTERA: BRACONIDAE) FROM INDIA[1]

S.M. Kurhade[2] and P.K. Nikam[3]

(*With three text-figures*)

Key words: Hymenoptera, Braconidae, Braconinae, *Iphiaulax* sp. nov.

Iphiaulax marathwadensis sp. nov. is illustrated and described. A key to the Indian species of *Iphiaulax* is also provided.

Introduction

Foerster (1862) erected the genus *Iphiaulax* with the type species *Ichneumon impostor* Scopoli. *Iphiaulax* belongs to the subfamily Braconinae and is distributed worldwide.

In India, only eleven species of *Iphiaulax* Foerster are recorded so far (Shenefelt 1978) and the following workers have contributed on the same: Brulle (1846), Cameron (1899, 1900, 1905, 1907, [1912] 1913) and Lal (1939).

In the present work, a new species *Iphiaulax marathwadensis* is described from material collected in India, Maharashtra, Aurangabad. The new taxon has been compared with seven species whose literature was available. A key to these Indian species of *Iphiaulax* is also provided.

Types have been deposited in the entomological collection of the Department of Zoology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.

Iphiaulax marathwadensis sp. nov.

(Figs. 1-3)

Female: Body (Fig. 1) 11.2 mm. Head (Fig. 2) transverse, 1.65 times as wide as long; vertex shiny, smooth, weakly punctate, pubescent; ocelli in equilateral triangle; frons concave, shiny, closely punctate with a median longitudinal suture, pubescent, 1.4 times as wide as long; face 1.8 times as wide as long, convex, closely punctate, pubescent, with a median longitudinal suture; antenna 2 + 84 segmented, longer than body, with fine pubescence throughout the length; scape 2 times as long as wide, shiny, closely punctate, pubescent; pedicel small, as long as wide, globular, shiny, closely punctate, with pubescence; flagellum long; clypeus narrow, finely punctate, pubescent; malar space narrow, closely punctate, with pubescence, 0.65 times the basal width of mandible; mandible stout, bidentate; eyes twice as long as wide, bare; interorbital distance as wide as the width of the eye; occipital carina absent; temple 0.7 times the width of eye, shiny, weakly punctate, with pubescence.

THORAX: 1.8 times as long as wide; pronotum shiny, smooth, weakly punctate, pubescent; mesoscutum shiny, smooth, weakly punctate, pubescent; middle lobe bulged; notauli distinct; scutellum convex, shiny, smooth, weakly punctate, pubescent; lateral carinae not distinct; mesopleurum shiny, sparsely punctate, with pubescence; mesopleural furrow distinct, extending 0.6 times the length of mesopleurum; metapleurum shiny, closely punctate, with pubescence; propodeum (Fig. 3) shiny, smooth,

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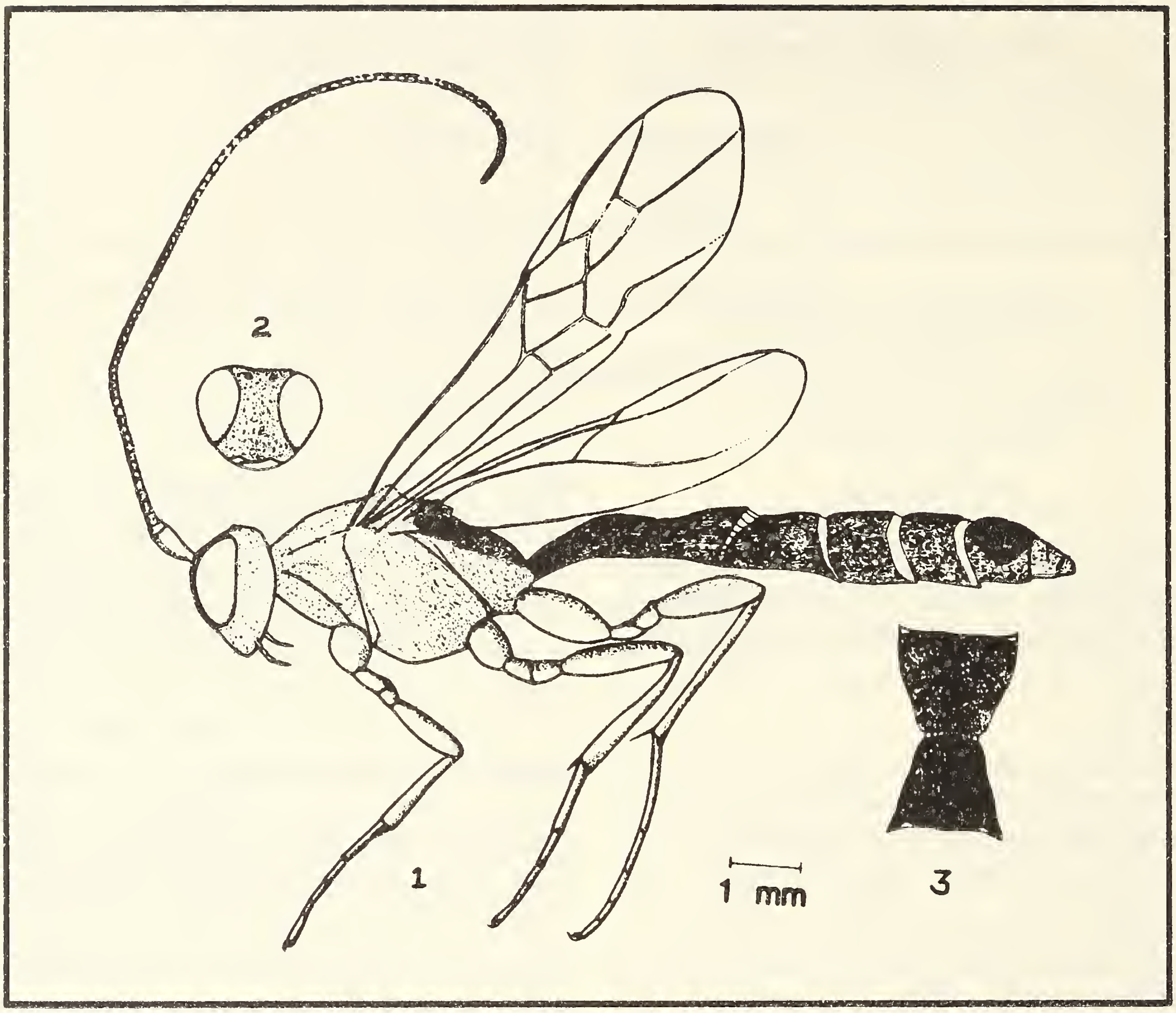

Figs. 1-3: *Iphiaulax marathwadensis* sp. nov. Female: 1. Lateral view, entire; 2. Head, viewed from front; 3. Propodeum with first abdominal tergite.

weakly punctate, with stout pubescence; propodeal spiracle large, oval. Hind coxa 2.3 times as long as wide, shiny, closely punctate, pubescent; trochanter I + II twice as long as wide, shiny, closely punctate; femur twice as long as wide, shiny, slender, closely punctate, with pubescence; tibia 6.5 times as long as wide, slender, wide at apex, closely punctate, with fine pubescence; long tibial spur 0.9 times the tibial width; tarsus 5 segmented; basitarsus elongated, finely punctate, with pubescence, 5 times as long as tibial spur; claw simple, bifid.

Forewing 4.8 times as long as broad; stigma 5.8 times as long as wide; metacarp 1.2 times as long as stigma; first abscissa of radius 0.6 times the second abscissa; second abscissa of radius as long as apical abscissa; third abscissa of radius not longer than r 1 + r 2; first intercubitus 1.3 times as long as 2nd intercubitus; second cubital cell 3 times as long as wide, with four unequal sides; cubitus 3 times as long as stigma, sclerotized throughout the length; costa 1.4 times as long as medius; nervulus slightly inclivous, 1.6 times as long as width of stigma; first brachial cell 2.3 times as long as wide; submedius 3 times as long as brachius; subdiscoideus 1.5 times as long as discoideus; anal cell 18.8 times as long as wide, with two dark brown patches in the middle and one faint brown patch in the apical region; hind wing 4.8 times as long as broad; nervellus reclivous, as long as submediella; basella 0.3 times the mediella, sclerotized; cubitella 0.8 times the mediella; radiella 0.6 times the subcostella.

ABDOMEN: 3.6 times as long as wide; first tergite twice as long as wide basally, 1.1 times as long as wide apically, excavated anteriorly, with dorsal carina, deeply strigose, sparsely punctate, with pubescence, dorsolateral carinae distinct; second tergite wider than long, 0.95 times its own width, deeply strigose, closely punctate, with pubescence; third tergite 1.7 times as wide as long, strigose mid-dorsally, rugose laterally, sparsely punctate, pubescent; remaining tergites rugose, closely punctate, pubescent; ovipositor 7.35 times as long as hind basitarsus; ovipositor sheath as long as ovipositor, with fine bristles throughout the length.

GENITALIA: Gonoforceps, volsellae and aedeagus situated on the sclerotic ring; volsellae enclosed by gonoforceps; gonosquammae short, strongly obliquely truncate, rounded apically, with stiff bristles at the apex; gonostipes curved; gonocardo pointed; gonolacinae weakly tapered apically, teeth absent; apodeme elongated; distivolsella moderately globular, pointed apically; basivolsella elongated; basivolsellar strut distinct; aedeagus moderately sclerotized, apically rounded, without teeth; parameres short, moderately globular, apically rounded; subgenital plate transverse, smooth; anticosta rounded, spiculum absent.

Body: Yellowish-red. Scape, pedicel, flagellum, tip of mandibles, ovipositor sheath dark brown to black; two patches and apical margin of forewing, one light patch and apical margin of hindwing, stigma, veins brownish-black.

Male: Agrees with female except (i) length 12.2 mm and (ii) malar space 0.7 times the basal width of mandible.

Holotype: Female, INDIA: Maharashtra: Aurangabad, 15. x. 1986, on wing,.Coll. P.K. Nikam; Antenna, wings and legs mounted on slides and labelled as above.

Allotype: Male, data same as holotype.

Paratypes: 6 females, 4 males, data same as holotype.

Remarks: In the key to the Indian species of *Iphiaulax,* the new species *Iphiaulax marathwadensis* superficially resembles *Iphiaulax sal* Cameron [1912] 1913 in having: (i) face closely punctate, (ii) first tergite with distinct dorsolateral carinae and (iii) wings fuscous. However, the new species differs from the same in the following characters: (i) vertex smooth, shiny, weakly punctate, pubescent, (ii) stigma dark brownish-black, (iii) third abscissa of radius not longer than first and second abscissa of radius, (iv) thorax shiny, smooth, (v) abdomen 3.6 x as long as wide, (vi) first tergite with dorsal carina, deeply strigose, sparsely punctate, with pubescence, (vii) second tergite deeply strigose, closely punctate, (viii) third tergite strigose mid-dorsally, rugose laterally, sparsely punctate and (ix) fourth tergite rugosely, closely punctate.

KEY TO THE INDIAN SPECIES OF *Iphiaulax*

1. The basal 5 abdominal tergites closely reticulate or punctate 8

— The basal 5 abdominal tergites differently sculpted 2

2. First segment of abdomen with basal slope smooth, shining, bordered by wide oblique crenulated furrow; body black. .... *sal* Cameron [1912] 1913

— First segment of abdomen not smooth, shining; body differently coloured 3

3. First segment of abdomen deeply strigose, with dorsal carina, sparsely punctate, with pubescence, dorsolateral carinae distinct; body yellowish-red., ... *marathwadensis,* sp. nov.

— First segment of abdomen differently sculpted; body not yellowish-red 4

4. Abdomen smooth. The apex of first abdominal segment finely striate in the middle; second tergite much more strongly, irregularly striate. .... *hookeri* Cameron 1907

— Abdomen not smooth 5

5. Petiole coarsely, rugosely punctate except in the centre at the apex; lateral furrows with a few

transverse keels; 2nd, 3rd, and 4th tergites more closely, rugosely punctate ....
.... *smenus* Cameron 1905

— Petiole not coarsely, rugosely punctate; 2nd, 3rd and 4th tergites differently sculpted 6

6. Abdomen irregularly, rugosely punctate; without keel on the base of the 2nd segment................
.... *elizeus* Cameron 1905

— Abdomen without rugose punctures 7

7. Basal three abdominal tergites, stoutly, longitudinally striate ....
.... *sikkimensis* Cameron 1907

— First tergite of abdomen with raised median triangular area, but with no keel in middle; apical margins of 2nd, 3rd and 4th tergites transversely grooved and longitudinally striate ....
.... *safderezae* Lal 1939

8. The basal five tergites of abdomen closely reticulate, punctate; suturiform articulation wide, crenulated ....
.... *immsii* Cameron [1912] 1913.

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* Original not seen.

■ ■ ■

A NEW SALTICID SPIDER FROM INDIA[1]

G.L. SADANA AND AARTI GUPTA[2]

(*With nine text-figures*)

Key words: Salticid spider, *Myrmarachne ludhianaensis* sp. nov., India.

A new species of spider *Myrmarachne ludhianaensis* sp. nov. of the family Salticidae is described and illustrated, and *M. laetus* Thorell has been recorded for the first time from Punjab State.

INTRODUCTION

Spiders of the family Salticidae, particularly of the genus *Myrmarachne* MacLeay, are inadequately known from the Indian region. Even the classic work of Pocock (1900) on Indian spiders makes no mention of this family.

One of the earliest contributions on Indian *Myrmarachne* was by Narayan (1915). Tikader (1972) in his Catalogue and Bibliography of Spider Fauna of India listed ten species of *Myrmarachne* from India. Subsequently (Tikader 1973), he recorded five species and of these, four were new. Thereafter, Mittal and Bradoo (1977) and Bradoo (1980) added three new species to the existing fauna and Sadana (1983) made the first record of *Myrmarachne laetus* from Jammu and Kashmir State.

During a survey of spiders predaceous on insect pests of fruit trees, we came across two species of *Myrmarachne,* one of which is new and described here as *M. ludhianaensis*. The other, *M. laetus* Thorell 1895, is already known from E. and S. India and Myanmar and collected for the first time from Punjab State. The total number of known species of the genus *Myrmarachne*, including *M. ludhianaensis*, is now nineteen.

The type specimens will be deposited in the collection of the Zoological Survey of India, Calcutta.

All measurements given in the description of species are in mm.

The abbreviations for different types of eyes are: AM- anterior median, AL- anterior lateral, PM- posterior median and PL- posterior lateral.

Myrmarachne ludhianaensis sp. nov.
(Figs. 1-9)

Cephalothorax: Female carapace length 2.30, greatest width 1.02; cephalic region brown with a broad dark band in the ocular region; almost as long as wide, high and flat, distinctly separated from the thoracic region by a deep transverse cephalic groove; thoracic region black, almost squarish, high anteriorly, slopes down posteriorly. Eyes: pearly white, encircled by black rims, arranged in two rows, anterior row slightly recurved, posterior row strongly recurved, ocular area wider than long, occupying less than half the length of cephalothorax. Diameter of eyes: AM=0.28, AL=0.13, PM=0.04, PL=0.14, Mutual distance between eyes: AM-AM=0.06, AL-AL=0.83, AM-AL=0.09, PM-PM=0.08, PL-PL=0.98, PM-PL=0.19, AM-PM=0.35, AL-PL=0.47. Chelicerae (Fig. 3): length 0.49, width 0.29, brown, promargin with five and retromargin with nine teeth, both margins with well developed scopulae. Labium (Fig. 2): length 0.41, width 0.33, brownish black, elongate, notched in the middle, anterior margin with black hair. Maxillary lobes (Fig. 4): length 0.45, width 0.30, yellowish brown, inner margin with scopula of

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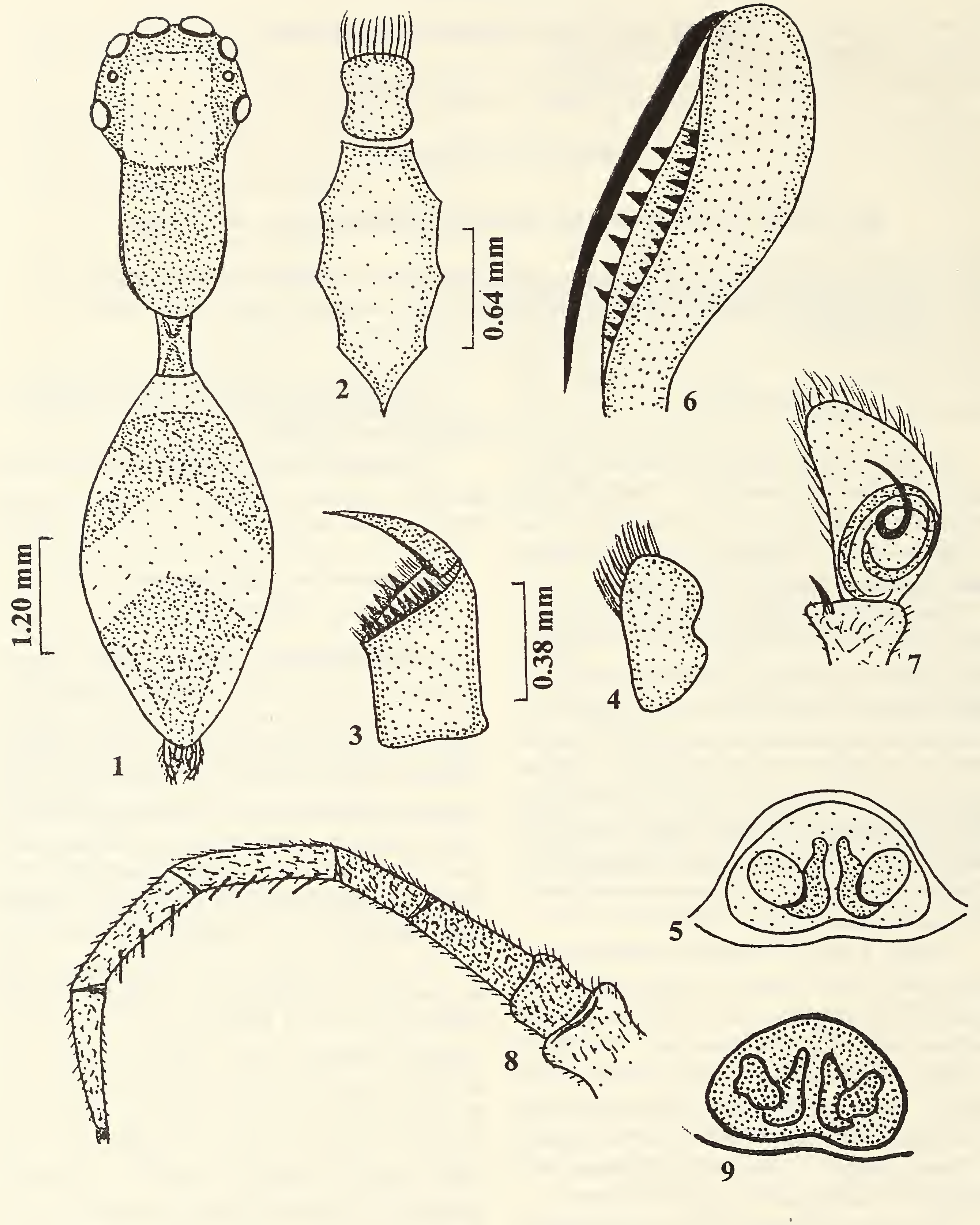

Figs. 1-9. *Myrmarachne ludhianaensis* sp. nov.: 1. Dorsal view of female (legs omitted); 2. Ventral view of labium and sternum; 3. Inner view of chelicera of female; 4. Inner view of maxillary lobe; 5. Ventral view of epigynum; 6. Inner view of chelicera of male; 7. Palpal organ; 8. Lateral view of second leg; 9. Inner (dorsal) view of epigynum.

dark brown hair. Sternum (Fig. 2): length 1.35 and width 0.46, brown, nearly three times as long as broad, produced between coxae. Pedipalpal tibia and tarsus flattened into an oar-like structure. Legs: long, thin, clothed with fine hair, yellow with trochanter, femur and patella brownish yellow, second and third coxae separated by a space, fourth coxae contiguous. The second pairs of legs distinctive in having four and three pairs of spines on the ventral side of their tibiae and metatarsi, respectively. Pedicel visible from above, elongate, adding to the length of the body. Length of legs: I-7.36, II-7.52, III- 8.22, IV-9.25.

Abdomen: Length 2.96, broadest width 1.08, yellowish with a dark band in the anterior half, band bifurcated towards the lateral sides, posterior half with a kite-shaped band. Venter yellowish with a broad, brown median band, sides black. Epigynum as in Figs. 5 and 9.

Male carapace length 1.98 and greatest width 0.83, resembles female in all respects except in having very long chelicerae and fangs (Fig. 6); promargin of cheliceral furrow with seven and retromargin with fifteen teeth. Palpal organ with cup-shaped cymbium, embolus small, pointed and sickle-shaped, located anteriorly.

Male abdomen: length 2.30, greatest width 0.92, brown with a transverse depression on the anterior half. Resembles female in other characteristics. Posterior spinnerets longer and more slender than anterior ones.

Total length: female 6.1 and male 5.5

Holotype: female, ex. pear, 17.xii.1992, Ludhiana, coll. Aarti.

Allotype: male, collection data same as Holotype.

Paratype: female, ex. grapevine, 7.v.1993, Ludhiana, coll. Aarti.

Distribution: Known from type locality.

Etymology: The new species is named after the type locality.

Remarks: This species resembles *M. bengalensis* Tikader slightly, but differs as follows:

Legs are yellowish and without any markings, but in *M. bengalensis* legs I and II are pale with conspicuous longitudinal deep brown markings and legs III and IV are deep brown. Besides, the leg formula in the new species is 4321, whereas in *M. bengalensis* it is 4132. Further, the basal segment of chelicera is cylindrical and the structure of epigynum and pattern on the abdomen is also different. It also differs distinctly from *M. chandigarhensis* Mittal and Bradoo (1977), *M. cheliceratus* (Mittal and Bradoo 1977) and *M. platypalpus* (Bradoo 1980) reported from northern India.

Myrmarachne laetus Thorell

Myrmarachne laetus Thorell, 1895, Spiders of Burma p. 320.

Material examined: 1 female, 2 males, ex. peach, 10.ix.1995 and 1 female, 1 male, ex. citrus, 5.ii.1996, Ludhiana, coll. G.L. Sadana.

Distribution: INDIA: Madras, Calcutta, Nicobar Islands, Jammu and Kashmir and Punjab. BURMA (Myanmaar).

ACKNOWLEDGEMENTS

We thank the Prof. and Head, Department of Zoology, Punjab Agricultural University, Ludhiana, for providing the necessary facilities and encouragement.

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A NEW SPECIES OF *PERODERMA* HELLER (LERNAEOCERIFORMES: COPEPODA) FROM SARDINES OFF THE PORTO NOVO COAST, INDIA[1]

A.J.A. Ranjit Singh[2] and P. Bensam[3]

(*With fourteen text-figures*)

Key words: *Peroderma sardinellae,* parasite, fish borer, rhizoid, copepod.

A new species of parasitic copepod (Lernaeoceriformes), *Peroderma sardinellae* sp. nov. was recorded from sardines netted in the Bay of Bengal off the Porto Novo coast of India. *Peroderma sardinellae* sp. nov. is a fish borer with anastomosing rhizoid-like structures to anchor itself in the bore and to absorb nourishment from the host. The female parasite has two elongated egg strings hanging out of the bore and the body of the parasite is buried inside the bore.

INTRODUCTION

The genus *Peroderma* Heller (Lernaeoceriformes, Copepoda) includes only two valid species so far, namely *P. cylindricum* Heller and *P. tasselum* Bennet. *P. branchiata* recorded by Basset Smith (1898) was synonymised as *P. cylindricum* by Wilson (1917), who recognised only a single species, *P. cylindricum*, under the genus *Peroderma.* Bennet and Chellam (1977) described a new species, *P. tasselum* from Indian waters. In the present observation on sardines, twenty six female specimens of the genus *Peroderma,* different from *P. cylindricum* and *P. tasselum*, were collected and are described as a new species. Yamaguti (1963) and Pillai (1965) give comprehensive reviews of the genus *Peroderma*. Detailed descriptions of *P. cylindricum* from Indian waters by Bennet (1961) and *P. tasselum* by Bennet and Chellam (1977) facilitate the comparison of *P. cylindricum* and *P. tasselum* with the present species.

MATERIAL AND METHODS

An infestation of *Peroderma* was observed on the sardines *Sardinella albella, S. gibbosa* and *S. dayi* collected from gill net catches. The parasites were dissected out from the dermal bore in the tissues of the host fish and identified. The type material will be deposited in the National Collection of Zoological Survey of India, Calcutta.

Peroderma sardinellae sp. nov.
(Figs. 1-14)

Female: Body elongate, irregularly cylindrical and divided into head, neck and trunk. Trunk elongated and cylindrical, club-shaped at anterior end, posterior end slightly broad having three bulbous swellings. The neck projection arises at right angles to the trunk. The origin of the neck is towards the anterior region, its position lies at 39-41% of the total length of the trunk. Body surface not smooth, lateral surface anterior to the origin of neck with about 7 projections which may help to get a hold inside the host tissue. The neck is a chitinous, irregular tube, bearing head and oral appendages at its distal end. The broad base of the neck is easily separable from the trunk. Neck hollow and opens

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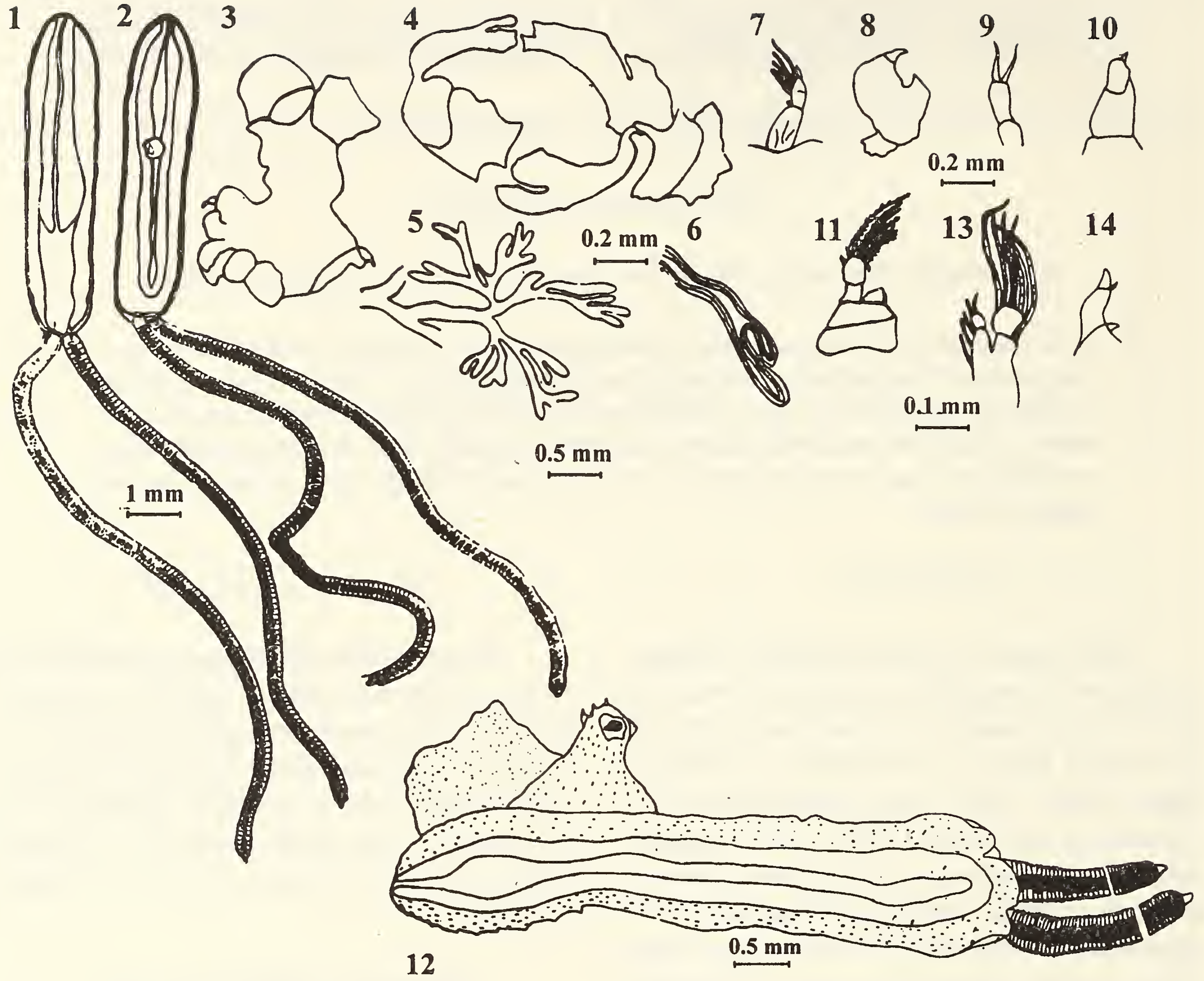

Fig. 1-14: Various body parts of *Peroderma sardinellae* sp. nov.: 1. Dorsal view; 2. Ventral view; 3. Oral tube; 4. Anterior portion of oral tube; 5. A branch of absorbing and anchoring roots; 6. An absorptive root; 7. Antennule; 8. Antenna; 9. Maxilla; 10. Maxilliped; 11. First walking leg; 12. Lateral view of the parasite; 13. Second walking leg; 14. Third walking leg.

into the trunk through a large, apparently bipartitioned opening.

The oral tube at its distal end bears a bunch of six irregularly branched chitinous, double walled, plate-like absorptive and anchoring roots which anastomose to deeper body tissues. The dorsal surface of the body is ridged by a pair of long rod-like structures that run longitudinally along the body. These join together to form a tube and open at the anterior region of the trunk. A similar structure is found on the ventral side, extending only upto the origin of the neck. This structure may be associated with the secretion of a proteolytic enzyme to aid in drilling into the body tissues of the host fish.

Antennules three-segmented, distal segment quite indistinct. Basal segment broad, bearing a single short seta; two distal segments bearing six long non-plumose setae, of which all except the first are long. The second and third antennular setae show signs of segmentation. Antenna three-segmented and appears chelate. First segment small, second segment large and

TABLE 1

DIFFERENCES IN THE CHARACTERS OF THE THREE SPECIES OF *PERODERMA* HELLER

Peroderma cylindricum Heller	*Peroderma tasselum* Bennet	*Peroderma sardinellae.* sp. nov.
Trunk short, cylindrical, a little bent, smooth with slight dorso-ventral flattening.	Trunk elongated, bent to dorsal side, irregularly cylindrical.	Trunk elongate, straight, uniformly cylindrical bearing many ridges and undulations on dorsal, ventral and lateral sides.
Pre-neck region of trunk cylindrical, nearly 17% of total length of trunk (Bennet 1961)	Pre-neck region of trunk swollen, nearly 50% of total length of trunk.	Pre-neck region club-shaped, 39-41% of total length of trunk.
Neck narrow, cylindrical, a little elongated and attached at right angles to trunk.	Neck short, narrow and cylindrical, attached at an angle with the trunk.	Neck stout, irregular, chitinous jacketed tube, attached not at right angles to the trunk.
Head somewhat globular, irregularly lobed with a bunch of long rhizoid-like outgrowths originating from middle of ventral surface of head. Mouth tube bulbous and slightly protruding, its free border fringed with fine hairs.	Head swollen and rounded, its dorsal surface with three unequal bulges, two lateral and one median, with a bunch of long, branched, tessellate filaments originating from ventral surface of the head anterior to oral appendages. Mouth tube protruding, marginal membranes fringed with hairs.	Head chitinous, swollen and sub circular, bearing 6-7 irregular bulges and carrying numerous elongated narrow chitinous jacketed absorptive filaments or roots which are distally branched in most filaments. Mouth tube not protruding, margin bordered with irregular, plate-like structures, marginal hairs absent.
Antennules somewhat club-shaped, three jointed structures carrying several stiff setae, third joint long with a long seta.	Antennules short, three segmented. Basal segment of antennule with three setae of which one is on the inter margin, middle segment with two setae and distal segment with seven setae of which the first and last are long.	Antennules long, three-segmented. Basal segment broad and bears a single short seta, distal two segments bear six non-plumose setae of which all except first are long. Distal segment less distinct.
Antenna three-jointed, sub-chelate, prehensile. First is short, second stout with its inner distal part produced into a triangular process against which the long fulcate third joint closes.	Antenna three segmented and chelate. First segment is stout and powerful. Second also stout but shorter than first, both with accessory structures. Third segment is a powerful chela.	Antenna three-segmented, chelation not clear. First segment small. Second segment stout. Third small and conical in shape.
Maxillipeds three-jointed, third joint slightly curved, second joint bearing numerous small blunt accessory claws.	Maxillipeds three-jointed, third joint in the form of a short claw provided with spinules along margin, second elongated and with a blunt spine at lower distal part. First segment thick and large.	Maxillipeds three-jointed. Third joint small, conical in shape, second segment long and curved and bearing a small spine at the distal part. First segment broad, bears a claw at distal end.
First pair of legs long, biramous, terminal rami bearing six simple setae.	First pair of legs biramous, terminal rami bearing seven simple setae.	First pair of legs biramous, terminal rami bearing six long denticles carrying setae.
Third pair of legs uniramous, indistinctly two-jointed and bearing a few short spines.	Third leg uniramous, three small segments without setae or spines.	Third leg uniramous, three segmented, distal segment bears small spine.
Posterior region of trunk narrow, caudal end without swelling. Furcal rami distinct.	Posterior region of trunk narrow, caudal end with bulbous swelling, furcal rami indistinct.	Posterior region of trunk cylindrical with an apparent notch on posterior side, caudal with three bulbous projections, furcal rami distinct.

stout, third segment small and conical. The chitinous projection on the inner side of the mouth tube is considered to be the mandible. The maxillae on either side of the buccal tube are two segmented, the distal segment with a pair of fine setae. Maxilliped three-jointed, the first segment broad, bearing a claw at its distal end. Second segment long and curved, bearing a small spine distally. Third segment small and conical in shape. Three pairs of legs are present in the neck region; first two pairs biramous, third uniramous. The details of structures in the first pair of legs are not clear. The basis of first pair of legs is broad and coxa is short. One ramus of first pair of legs bears two segments which bear two pointed spinous projections and six denticles bearing many minute setae. Second leg biramous with one ramus bearing six fine long denticles and the other only five denticles. The denticles appear to be segmented with no setae. The third leg is uniramous, three segmented and the distal segment bears a small spine. Caudal region of trunk has three bulbous projections, bearing two long uniseriate filamentous egg-strings which are about 2.61 times longer than the length of the parasite. Two very small caudal furca are attached just beneath the origin of the ovisac.

P. sardinellae is similar to *P. cylindricum* Heller and *P. tasselum* Bennet in the mode of attachment to the host, the elongate body with neck roughly at right angles to the trunk, in the structure of oral appendages, segmentation of two pairs of biramous legs and the presence of uniseriate filamentous ovisac. However, there are differences from these two species, as listed in Table 1 and discussed below.

From Table 1 it may be seen that the present species differs from *P. tasselum* in the shape of the trunk, position of neck in the trunk, length of pre-neck region, absence of tassel-like head process with nodulations, the structure of antennules, antennae, maxillipeds, first and second pairs of walking legs, and in the shape of the posterior region of the trunk. These differences may be used to separate the present species from *P. tasselum*. The new species differs from *P. cylindricum* in the presence of a straight, uniformly cylindrical trunk with rough body surface; the presence of club-shaped pre-neck region covering 39%-41% of the total trunk length, presence of stout, irregular chitinous neck not originating exactly at right angles; the absence of sub-globular head with irregular lobes; rhizoid-like head process originating from a common head peduncle, mouth tube with marginal hairs; the presence of first pair of legs bearing six denticles carrying setae and three-segmented third leg without spines and terminal claw and in the shape of the posterior region of the trunk.

The specimens are thus of a new species belonging to the genus *Peroderma* and are named *Peroderma sardinellae* sp. nov.

Collection Data:

Holotype	:	female
Paratype	:	26 females
India	:	Tamil Nadu, Bay of Bengal, Porto Novo
ex.	:	*Sardinella albella,* *Sardinella gibbosa,* *Sardinella dayi*; 16.v.1990
coll.	:	A.J.A. Ranjit Singh

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BIOSYSTEMATIC STUDY OF TWO NEW SPECIES OF *CHENOPODIUM* FROM THE NORTH INDIAN PLAINS[1]

S.C. Pandeya, Geeta Singhal and Anil K. Bhatnagar[2]

(*With four text-figures*)

Key words: *Chenopodium santoshei, C. cyanifolium,* leaves, stem, colouration, stigma.

Two populations of *Chenopodium* aggregate occurring in the north Indian plains have been distinguished and described as *Chenopodium santoshei* sp. nov. and *C. cyanifolium* sp. nov.

INTRODUCTION

Chenopodium album and its allies (non-aromatic, edible), belonging to family Chenopodiaceae, are cosmopolitan (Uotila 1976-1978, 1988, 1993 a, b, c) annual herbs. They occur naturally throughout the north Indian plains as weeds in cultivated winter crop fields, in gardens, among debris and other moist places, flowering from November to April. The ecoclimate of the region is tropical semi-arid, and the soil is Pleistocene and fresh alluvia.

In the region, at least two distinct populations of *Chenopodium* aggregate occur, which differ from known species of the genus. Both are non-aromatic and edible. They are:

1. *CC* (greyish-cyan leaves) - An erect, tall, herbaceous plant, starts growth in October/November, flowering February to April; height upto 2.50 m; stem ridged, almost uniformly purple, basal branches longer (upto 65 cm), decumbent, giving the mature plant a triangular shape; leaves - petiole reddish green, lamina greyish-bluish-green (cyan), petiole equal to or longer than lamina, lamina ovate, bracts elliptic, margins soft dentate, lamina 1.2-4.5 x 0.6-3.2 cm, petiole 0.5-3.3 cm, leaf primordia greyish green, mealiness on young stem, leaves and perianth; inflorescence greyish-bluish-green, spikes terminal (30 cm) and axillary, flowers - perianth 5, central vein less prominent, stamens 5, equal to perianth, feathery stigma bi- and trifid, longer; seed covered with pericarp with a circular opening on the top, disc-shaped, 1 mm x 0.98 mm, thickness 0.56 mm, colour Hue 5R 2/1 (Figs. 1 and 2). Deposited at Kew, vide ours DEI 102.

2. *CS* (entire red) - An erect, tall (2.0-3.5 m) herbaceous plant, starts growth in November, flowering February to April; stem ridged in the beginning, smooth on maturity, branching throughout, almost uniformly scarlet, stele scarlet (as seen in transverse section), middle branches longest upto 1.3 m, shape of plant oblong, diameter of main stem at base upto 4.5 cm, young branches reddish green; leaves greenish-red on dorsal side, green on ventral side with scarlet veins, leaves turning completely crimson upon senescence, shape hastate, three-lobed, middle lobe oblong, basal 2 lobes pointing upwards with one large and one small dentation, apex of middle lobe acute to obtuse, 2-3 dentations, lamina with heavy mealiness on young leaves (also on young stem and perianth), getting glabrous on maturity, leaf primordia scarlet, lamina 1.5-8.5 x 0.6-6.6 cm, petiole 0.8-9.2 cm (longer than lamina), ratio of length/width of lamina 1.28, between lamina and petiole 0.92; spikes terminal on main stem upto 18 cm

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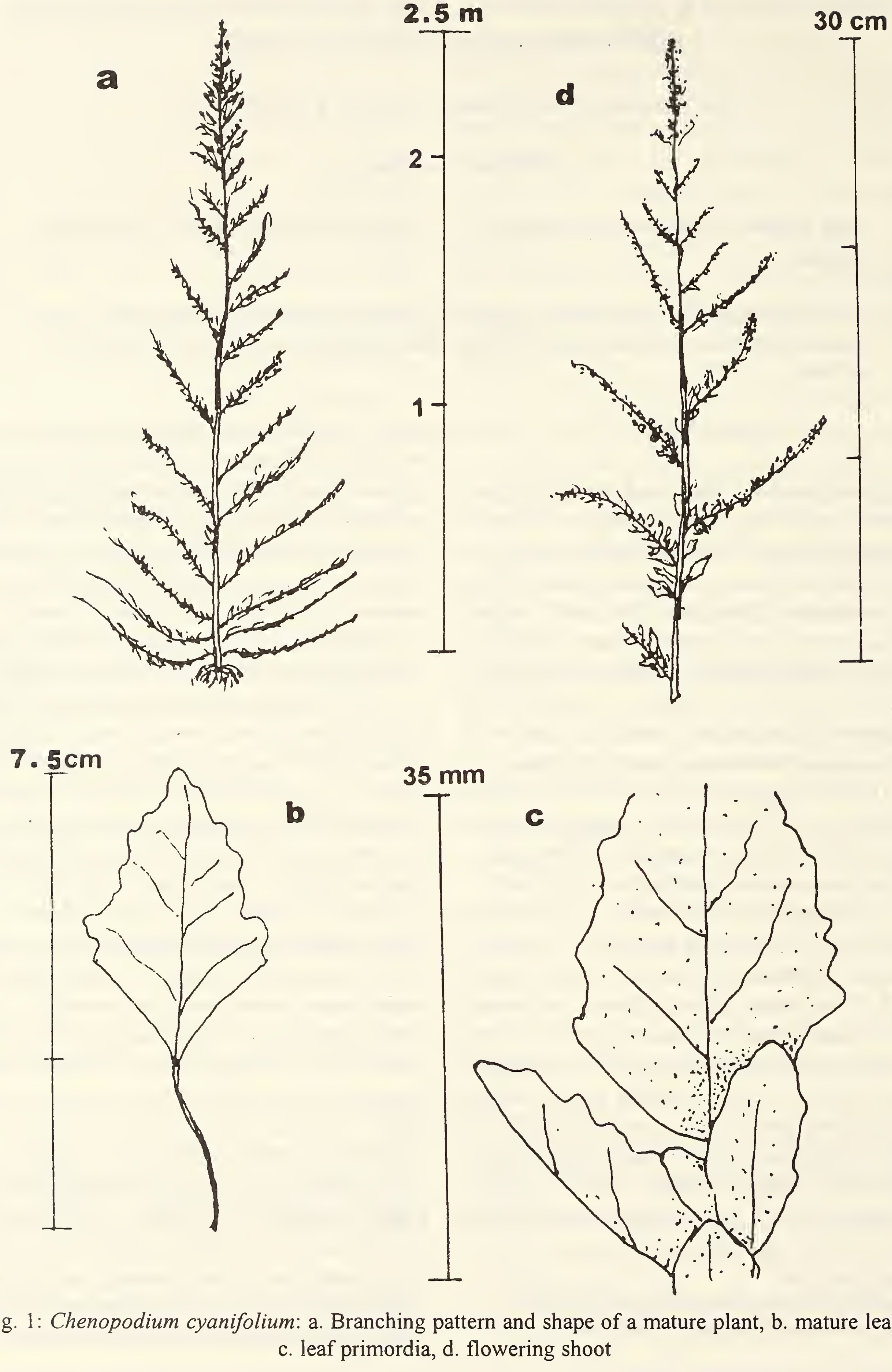
a
2.5 m
2
1
d
30 cm
7.5cm
b
35 mm
c

Fig. 1: *Chenopodium cyanifolium*: a. Branching pattern and shape of a mature plant, b. mature leaf, c. leaf primordia, d. flowering shoot

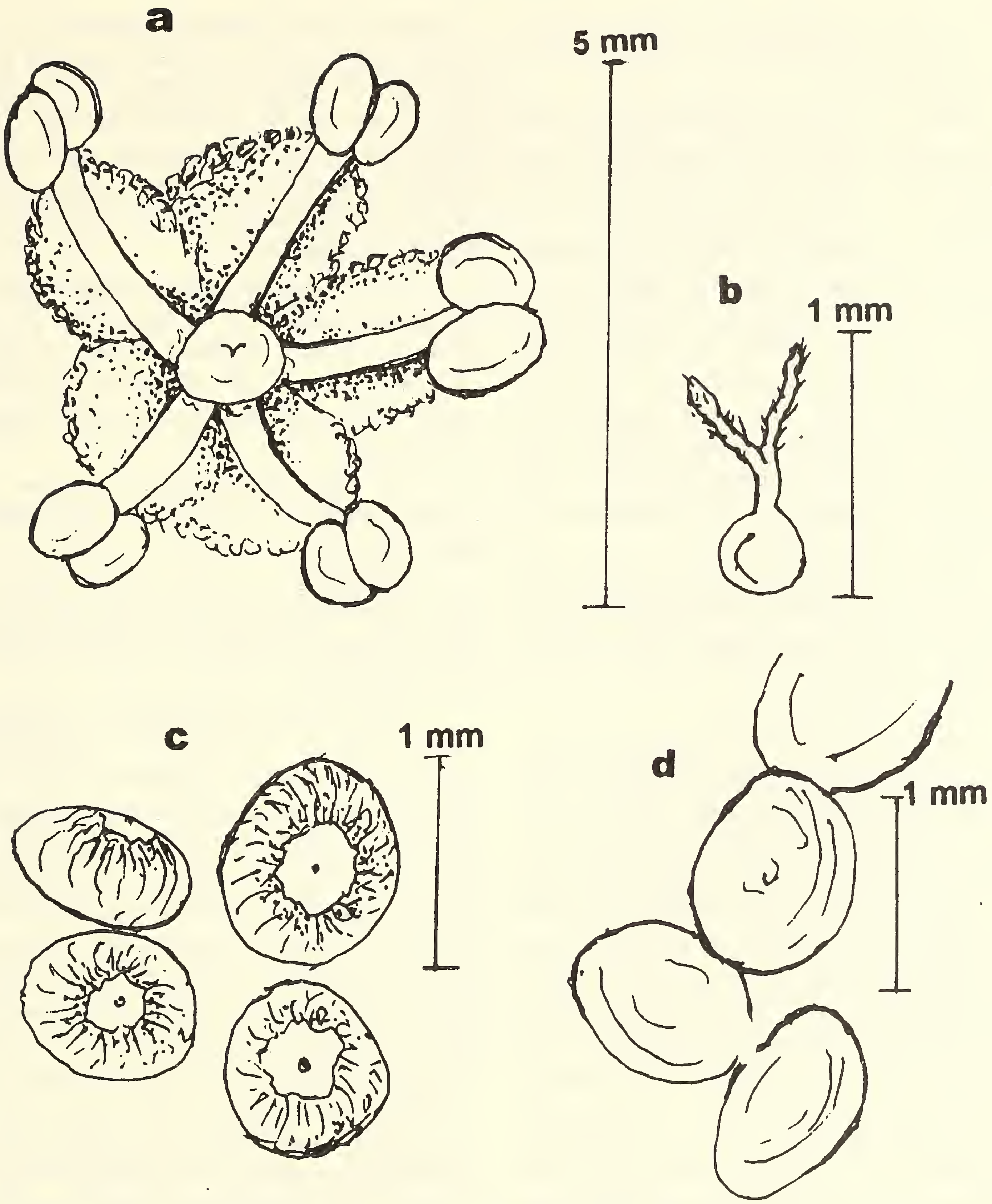

Fig. 2: *Chenopodium cyanifolium*: a. open flower, heavy mealiness on perianth, filaments (of stamen) equal to perianth, b. bifid stigma, c. seeds with pericarp, d. seeds without pericarp

along with branches, greenish red spikes on all primary, secondary and tertiary branches from base upwards, bracts broad lanceolate but with two small projections on either side; flowers, perianth 5, connate at base, margins scarlet, stamen 5, filament longer than perianth, feathery stigma 2, 3, 4-fid, smaller than *CC,* perianth midrib not prominent, pericarp adherent with a circular opening on top; seed disc-shaped (biconvex), notched with a depression, length 0.92 mm, width 0.89 mm, thickness 0.51 mm, colour Hue 5R 2/1, weight of 100 seeds with pericarp 0.0270, without 0.0243. Fig. 3 and 4 Type - north Indian plains, Agra, deposited at Kew, our DEI 103.

Both *CC* and CS populations have been clubbed together in different Indian Floras under *Chenopodium album* Linn. and described as variations in morphological characters (Hook.f.in Fl. Br. Ind. 5:3, 1886; Prain, Bengal Plants, 2:879, 1903; Cooke, Fl. Indian desert, Sr. 4:968 (65), 1919; Gamble, Fl. Pres. Madras, Pt. IV: 1179, 1921; Duthie, Fl. Upper Gang. Plains & Adj. Siw. Sub-Him. Tr. 1903-29; Maheshwari, Fl. Delhi 302, 1963; Saldanha and Nicolson, Fl. Hassan Dist. Karnataka, India. 101, 1976; Babu, Herb. Fl. Dehradun, 436-37, 1977; Kaushik, Fl. Shivpuri, 279, 1983; Bhandari, Fl. Indian desert, 296, 1990.

In the present communication, an attempt has been made to clearly distinguish the two populations and to assign them to their correct systematic position.

TAXONOMIC CONSIDERATION

Specimens of both *CC and* CS were sent to the authority on the subject, Prof. Pertti Uotila, Helsinki, Finland, for his opinion. He wrote "*CC* seems to belong to *Chenopodium strictum* Roth. It is fairly badly known (sic) species described from India, and widely distributed but divided into several races. The stem is typically violet red, inflorescence spiciform and seeds smaller and more oval than in *C. album.* The leaf shape (in our material) is somewhat odd compared with the material I have seen earlier." In the present study *CC* does not tally with *C. strictum* or its known subspecies. Table 1 gives a comparative description of *C. strictum* Roth and its two subspecies, viz., *strictum* and *striatiforme* and the present *CC.* From the table it becomes clear that *CC* is a separate taxon and hence is being elevated to the rank of species, named:

Chenopodium cyanifolium Pandeya *et al.* sp. nov.

It is being characterised as:

Herba erecta, 2.5 m alta, cortice purple; lamino grey cyano, ovatis; petiolum aequalibus vel quam laminum longior (Lamino 4.5 x 3.2 cm, petiolata 3.3 cm alta); Inflorescence grey-cyano, stigma longior, bi-trifidus; Foliis extracta pH 7.72, sp. con. 38 μ mho; Floribus Feb.-April. Holotypus: Lectus in Dayalbagh, Agra (India). Positus in herbario die Botany Department, Dayalbagh Educational Institute, Agra, India sub numero accessionis 102.

Chenopodium folis rhomboideo - triangulari - album bus erofis poftice integris: fummis oblongis, racemis erectis. Fl. fuec. 212.Dalib, parif. 80 *Chenopodium* folis enferiorbus ovatis anthrorfum dentatis: fummis lanceolatis.

Vir. Cliff. 22 Hort Cliff. 85. Gron. virg. 145 Roy. lugdb. 219. Hall belv. 175. Habitat in agris Europa:

Etymology: *C. cyanifolium* has been named after the greyish-cyan colour of leaves and inflorescence, not present in any other species of *Chenopodium.*

Regarding the *CS* population, Uotila (pers. comm.) opines that "your *Chenopodium santoshei* belongs to *C. ficifolium* Sm., s. lat., e.g., on the basis of seed characters. This species seems to be variable especially in India and SE Asia. Two subspecies have been distinguished, mainly on the basis of seed coat characters: subsp. *ficifolium* (European) and subsp. *blomianum* (S and SE Asiatic). The latter have been divided into several races on the basis of leaf characters. However, leaf size and shape vary much within all taxa of *Chenopodium,* and based on my insufficient knowledge on Indian material, I am not willing to definitely say which kind of taxonomic recognition your specimen deserves, if any. It has exceptionally large and broad leaves for the species. Further red colour is exceptional, even though not unknown in *C. ficifolium.*

Table 2 gives a comparative account of *C. ficifolium* and its two subspecies along with *CS* population. The distinction is clear from the table. Hence, *CS* population is being named as:

TABLE 1

COMPARATIVE STATEMENT OF MORPHOLOGICAL CHARACTERS OF *CHENOPODIUM STRICTUM, C. S. STRICTUM, C.S. STRIATIFORME*(MURR.) UOTILA AND *C. CYANIFOLIUM* SP. NOV.

Characters	*Chenopodium strictum* Roth. Nov. Pl. Praes. Ind. or.	*Chenopodium strictum strictum* (Krasan) J. Murr. & Uotila.	*C. strictum striatiforme* (Murr.) Uotila comb. nova.	*C. cyanifolium* sp. nov.
Habit	—	Annual, upto 2 m tall, erect.	Height usually less than 40 cm, but sometimes 100 cm; erect to ascending.	Tall erect herb upto 2.5 m.
Stem	—	Green-striped, sometimes red especially in axils.	Stem and main branches yellowish to reddish, striped with various shades of green, sometimes violet red in the basal part.	Striped, uniformly purple, small branches reddish green.
Branching	Branching on the basal part	Branched mostly basally, lowermost branches long, ascending from almost horizontal base.	Usually richly branched basally, basal branches long and procumbent to ascending after a shortish horizontal part (typical of *glauco- phyllum* and *strictum* subspecies).	Basal branches longer, upto 65 cm, decumbent, giving the plant a triangular shape, young stem and young branches with heavy mealiness.
Leaves	Elliptic, glaucous	Lamina dark olive green to glaucous green above, glaucous green below, sometimes red rimmed, *c.* 2 x length of petiole, 2- 5 x 3-2.5 cm; ovate to elliptic, somewhat attenuate towards apex, margins almost parallel in the middle part, margins ± regularly toothed, teeth small, sometimes with a pair of longer teeth at broadest point of lamina, sometimes margins entire; apex rounded; lamina of upper leaves (rarely of all leaves) narrowly trullate to narrowly elliptic, margins entire.	2-2.5 (-3.5) x 0.7-1.0 (- 2.0 cm), rhombic trullate, with a cuneate base, margins entire to dentate, teeth ranging from blunt and shallow to fairly large, sparse and irregular, glaucous on the lower surface and margins often reddish, upper leaves and those on the branches have fairly long petiole, lamina elliptic 1-3 cm x 0.5 - 1.0 cm.	Ovate, lamina greyish bluish green (cyan), petiole reddish-brown, young leaves with heavy mealiness, shoot apex (primordia) greyish green, margins bluntly toothed pointing upwards, apex obtuse to somewhat pointed, petiole equal or longer than lamina, upto 4.5 x 3.2 cm, petiole upto 3.3 cm, upon senescence leaves turn olive green.

TABLE 1 (CONTD.)

COMPARATIVE STATEMENT OF MORPHOLOGICAL CHARACTERS OF *CHENOPODIUM STRICTUM, C. S. STRICTUM, C.S. STRIATIFORME* (MURR.) UOTILA AND *C. CYANIFOLIUM* SP. NOV.

Characters	*Chenopodium strictum* Roth. Nov. Pl. Praes. Ind. or.	*Chenopodium strictum strictum* (Krasan) J. Murr. & Uotila.	*C. strictum striatiforme* (Murr.) Uotila comb. nova.	*C. cyanifolium* sp. nov.
Inflorescence		Flowers concentrated in small glomerules, mostly arranged in terminal and usually spiciform branched inflorescence.	Flowers in fairly small compound glomerules, giving spike like appearance to more or less elongated branches of the inflorescence .	Terminal spikes long upto 30 cm, compact glomerules, spikes on branches small, inflorescence greyish bluish-green.
Flowers		Small, perianth olive green, united at the base, keel not prominent.	Small.	Flowers not small, perianth not small, perianth connate at base, stamen filaments equal to perianth, feathery stigma bi-trifid, long, mealiness on perianth, perianth greyish green, keel on perianth less prominent.
Fruit and Seeds		Fruits falling with perianth, pericarp easily detached, seed horizontal black, lustrous, 1.0-1.2 mm in diameter, somewhat ovate, length/width 1.12, thickness 0.55 mm.	Seed length 1.14 mm, length/width 1.10, thickness 0.55, notched.	Pericarp completely adherent with a ciurcular opening at the top, seed colour HUE 5R 2/1, length 1 mm width 0.98 mm, thickness 0.56 mm, weight of 100 seeds with pericarp 0.0344, without pericarp 0.0312 g, seeds notched.

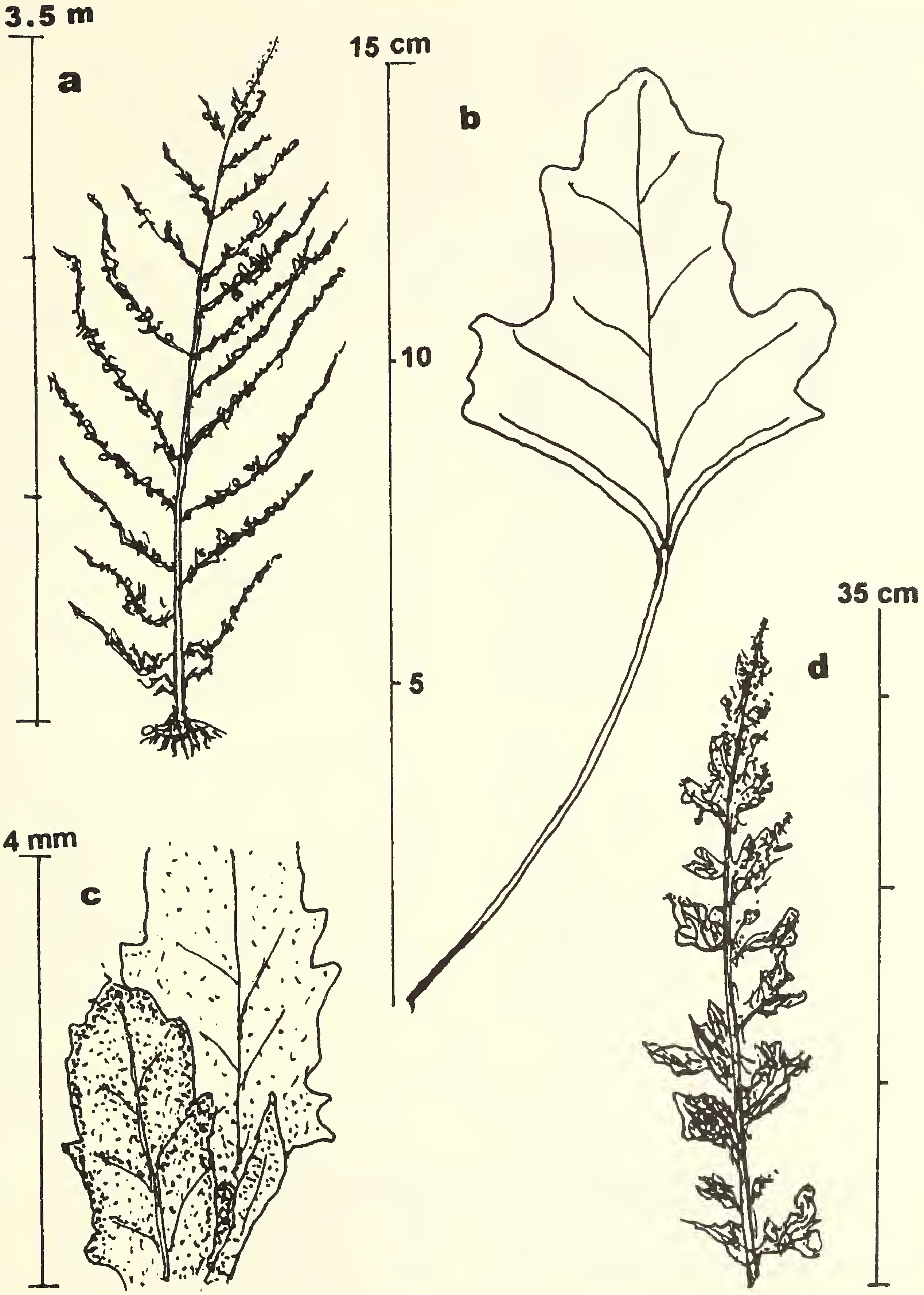
3.5 m
a
15 cm
b
10
5
35 cm
d
4 mm
c

Fig. 3: *Chenopodium santoshei*: a. branching pattern and shape of a mature plant, b. mature leaf, c. leaf primordia, d. flowering shoot

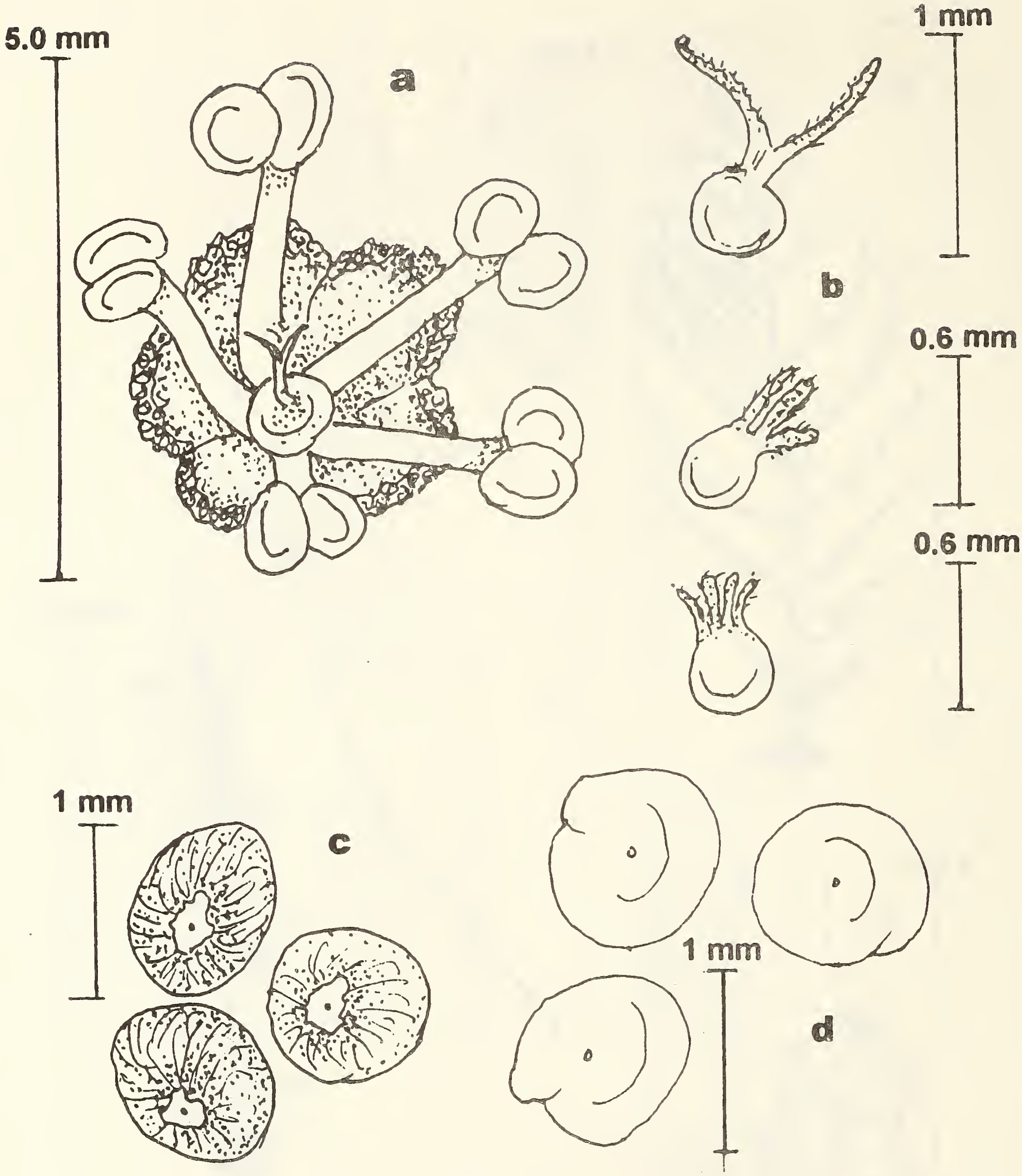

Fig. 4: *Chenopodium santoshei*: a. flower, filaments of anthers longer than perianth, b. long bifid, trifid and quadrifid stigma, c. seeds with pericarp, d. seeds without pericarp

Chenopodium santoshei Pandeya *et al.* sp. nov.

Etymology: The species has been named in honour of Dr. Santosh Chandra Pandeya, who first showed the plant to the senior author at Lucknow.

Chenopodium santoshei is being characterised as:

Herba erectus, 3.5 m alta; Trunkus diam. 4.5 cm; caulis rami, petiolata, foliis nervo rosea;

TABLE 2

COMPARATIVE STATEMENT OF MORPHOLOGICAL CHARACTERS OF *CHENOPODIUM FICIFOLIUM* SM., *C. F. FICIFOLIUM* (HEGI 1960) UOTILA, *C. F. BLOMIANUM* (AELLEN) AELLEN AND *CHENOPODIUM SANTOSHEI* SP. NOV.

Characters	*Chenopodium ficifolium* Sm.	*Chenopodium ficifolium ficifolium* (Hegi,1960) Uotila 1993	*C. ficifolium blomianum* (Aellen) Aellen	*C. santoshei* Pamdeya *et al.* sp. nov.
Height	20-70 cm.	-	-	2- 3.5 m
Stem	Erect, green, striped, sometimes yellow or tinged with red, rarely with red spots in leaf axils.	-	-	Erect, ridged, almost uniformly scarlet, stele of stem scarlet as seen in transverse section, mature stem at base circular, diameter at base upto 4.5 cm
Branches	Branches spreading, fairly short.	Branches mainly in upper parts	Much branched in basal parts	Branching throughout from base to top, middle branches longest upto 1.3 m, diam.1.0 cm, mature branches reddish green
Leaves	Fairly thin, glabrous or farmose, petiole as long as or shorter than lamina, lamina 2-5 cm, elliptic or ovate, usually with forward projecting tooth or lobes on both sides near base, middle lobe ± oblong, with several teeth or sometimes subentire, obtuse to truncate at apex	Mostly pure green, large, usually with prominent side lobes, middle lobe entire or dentate	Greyish-green, small to fairly large, truncate at apex, dentate, side lobes usually not very prominent or if so, the middle lobe broad and short	Reddish-green on dorsal side, green with blue tinge ventrally, veins scarlet, leaves turning crimson upon senescence, shape hastate, 3-lobed, basal 2 lobes broad and pointing upwards with one large and one small dentation, middle lobe large with parallel margins or so, 2-3 dentation on the upper side, apex acute to dome-shaped, young leaves with heavy mealiness on ventral and lighter on dorsal surface, mature leaves glabrous on upper surface, petiole always longer than lamina, lamina upto 8.5 x 6.6 cm, petiole 9.2 cm, ratio of L/W of lamina 1.28, and between length of lamina/petiole length 0.92, shoot apex (primordia) scarlet.

TABLE 2(CONTD.)

COMPARATIVE STATEMENT OF MORPHOLOGICAL CHARACTERS OF *CHENOPODIUM FICIFOLIUM* SM., *C. F. FICIFOLIUM* (HEGI 1960) UOTILA, *C. F. BLOMIANUM* (AELLEN) AELLEN AND *CHENOPODIUM SANTOSHEI* SP. NOV.

Characters	*Chenopodium ficifolium* Sm. Fl. Brit. 1: 276,(1800)	*Chenopodium ficifolium ficifolium* (Hegi,1960) Uotila 1993	*C. ficifolium blomianum* (Aellen) Aellen	*C. santoshei* sp. nov.
Inflorescence	Terminal, much branched rather loose panicle, leafless only in terminal parts, bracts narrowly lanceolate, usually entire, glomerules small.	–	–	Terminal on main stem (upto 16 cm) and on all primary, secondary and tertiary branches from base upwards, spikes compact, greenish red, bracts broad lanceolate but with two small projections on either side near middle.
Flowers	Perianth segments connate to middle, stigma 2.	–	–	Perianth connate at base with scarlet to crimson border and heavy mealiness on outer side, filament of stamen longer than perianth, feathery stigma shorter than *CC* population, stigma 2,3 or 4-fid, purple.
Fruits and Seeds	Pericarp fairly adherent seeds horizontal, black 0.8-1.0 mm, roundish in margins obtuse.	Pericarp somewhat adherent.	Pericarp fairly adherent.	Pericarp completely adherent with a circular opening on the top, seed disc-shaped (biconvex), notched with a depression, length 0.92, width 0.89 mm, thickness 0.51 mm, colour of seed HUE 5R 2/1, weight of 100 seeds with pericarp 0.0270, without pericarp 0.0243 g.

foliis hastatus, 3 lobus, lamino 8.5 x 6.6 cm; petiolum 9.2 cm alta; foliis primordium rosea; perianthus rosea; stamen filament longior quam perianth; foliis extracta: pH 6.0, sp. Con 45 μ mho; Floribus Feb.-April. Holotypus: Lectus in Dayalbagh, Agra et Lucknow (India). Positus in herbario die Botany Department, Dayalbagh Educational Institute, Agra, India sub numero accessioris 103.

ACKNOWLEDGEMENTS

We thank Prof. Pertti Uotila, Finnish Museum of Natural History, Finland, Botanical Museum, University of Helsinki, Finland for his useful opinion on the specimens. We also thank Prof. A.B. Bhatt, Srinagar (Garhwal) for providing the Latin description and for perusing the manuscript.

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■ ■ ■

A NEW SPECIES OF *GONIOTHALAMUS* BLUME (ANNONACEAE)[1]

SUCHANDRA R. DUTTA[2] AND S.M. ALMEIDA[3]

(*With six text-figures*)

Key words: *Goniothalamus shraddhae* sp. nov., Annonaceae, Kathambari, W. Bengal.

Goniothalamus shraddhae Dutta and Almeida, a new species, is described in detail. The Latin diagnosis, illustrations, similarities and differences of the present species and its closely related congeneric, *Goniothalamus ridleyi*, are provided in support of the new species. The holotype has been deposited in Blatter Herbarium.

INTRODUCTION

While doing field work in Kathambari area, Jalpaiguri dist., West Bengal, we observed an evergreen fruiting tree which looked like a member of the family Lauraceae. After collecting the material, we realised that it belonged to the family Annonaceae. Critical studies on the collected material were done at Blatter Herbarium; and to confirm its identity, work was done at Central National Herbarium, Calcutta and Western Circle, Pune. It was confirmed that the specimen belonged to a species of *Goniothalamus*, Blume. After referring to the vast literature on Annonaceae of India at BLAT, BSI Calcutta and Pune, it proved to be a new species of *Goniothalamus* Blume. Microscopic studies such as wood anatomy, stomatal type, epidermal appendages and seed anatomy carried out on the collected material helped to confirm the identity of the genus *Goniothalamus*.

Detailed description of the species, Latin diagnosis and line drawings are provided in the text.

Goniothalamus shraddhae sp. nov.

Similiss *Goniothalamus ridleyi* King. foliis membranaeceis cum basibus acutis apicibus acuminatis et carpellis sessillibus sed differt petiolis longioribus drupis sessilibus cum parietibus crassis cum basibus "U" formatis leviter sculcatis cremeis semenibus secretionibus gummosis.

This species is similar to *Goniothalamus ridleyi* King, in having membranous leaves with acute base and acuminate apex and almost sessile carpels. The new species differs from it in the following characters: longer petiole, sessile, thick walled drupelets with "U" shaped, slightly grooved base, and cream coloured seeds oozing a gummy secretion.

Holotypus- SD 470 (BLAT). Holotype- SD 470 (BLAT), St. Xavier's College, Mumbai.

Locus - Churabhija, Sialdoba Locality- Churabhija, Sialdoba.

Lectus: 21 Novembre, 1995, date of collection 21st November, 1995

Goniothalamus shraddhae sp. nov.
(Fig.-1)

Evergreen bushy tree; 2.5-3 m in height, having ash coloured stem attaining about 15-20 cm diameter at the base; branches arise slightly above the axil of the leaf, black in colour. Leaves simple, alternate, exstipulate, ovate-lanceolate, acuminate, acute at the base, 10-12 cm x 3.75 -5 cm; margin entire, thick, rolled inwards, reticulately veined; midvein very prominent on the ventral surface, continuous with the petiole about three-fourth of the length of the lamina,

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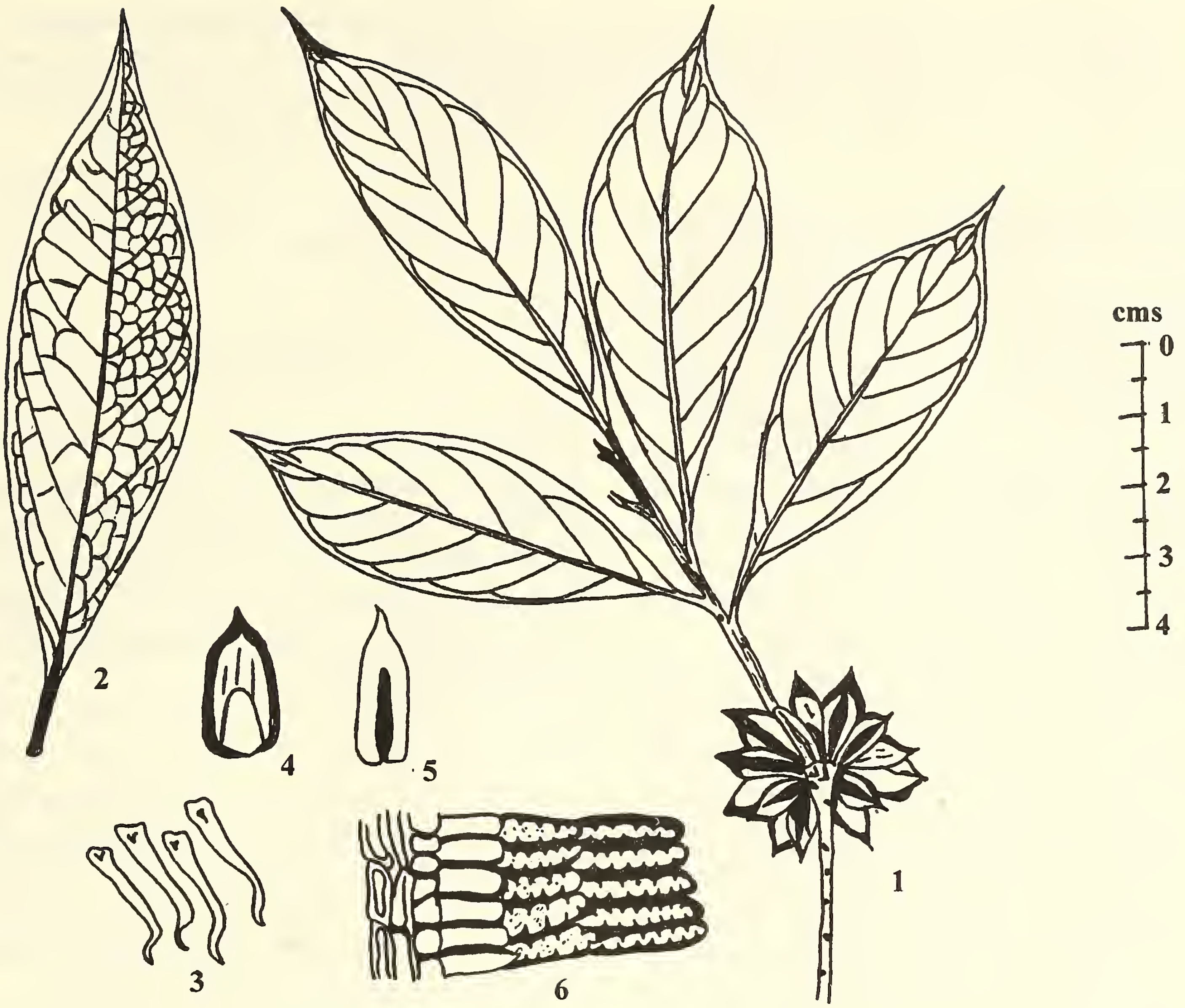
[3] Blatter Herbarium, St. Xaviers' College,
Mahapalika Marg, Mumbai-400 001.



Goniothalamus shraddhae Dutta and Almeida Annonaceae
Figs. 1-6: 1. Fruiting twig; 2. Ventral surface of the leaf showing details;
3. Epidermal appendages of leaf; 4. Drupelet showing 'U' shaped groove; 5. L.S. of drupelet;
6. Seed showing ruminate endosperm.

striate. Lateral veins 10-16, running towards the margin, finally meeting at the apex, basal veins straight, upto half of the distance of the lamina, later undulate, forming a curve and uniting with the apex of the lateral veins and nervules; nervules many, forming a close network, pubescent in nature, hairs visible only under the microscope. Petiole 1.5 - 2 cm long, slightly brownish black in colour, deeply grooved on the dorsal surface and rounded on the ventral surface. Fruit an etaerio of drupes, in clusters on the branch around a swollen axis giving a stellate appearance, closely packed, 20-22 in number leaving little gaps between the fruitlets (visible only in fresh condition); each fruitlet sessile, oblong, glossy green when young, brownish-black at maturity, compressed after pressing; base of the fruitlets slightly grooved, apex narrowly acute, terminating in a very short acumen. In dry condition the fruit is very hard with a lauraceous odour, grooved on one side and flattened on the other. Fruit in L.S. hollow in the centre, epicarp brownish, mesocarp white, seed with gummy substance. Endosperm ruminate. Seed single 1.5-1.7 cm x 0.8 cm with a short basal stalk, erect, 3 ribbed, occupies three-fourth the length of the fruit. L.S. of the seed shows simple pitted ruminate endosperm with gummy secretion oozing out.

This species is very closely allied to *Goniothalamus ridleyi* King. Detailed study on the fruiting material showed the following differences:

G. ridleyi King.	*G. shraddhae* sp. nov.
1. Petiole 1.5-2 cm long.	Petiole 2-2.7 cm long.
2. Ripe carpels stalked, stalk 5 mm. long	Ripe carpels sessile.
3. Base of the drupelet not grooved.	Base of the drupelets slightly grooved, U-shaped
4. Drupe thin walled.	Drupe thick walled.
5. Seed pale brown coloured	Seed cream coloured.
6. Seed slightly hairy, not having gummy secretions.	Seed glabrous oozing out gummy. secretions.

Etymology: This species is named after Miss. Shraddha Shimpi, a close friend of the first author and a teacher in Botany, who inspired her during her undergraduate studies.

This is a very rare species in the evergreen forest area. Attempts to collect the plant in flowering condition were not succesful.

ACKNOWLEDGEMENT

We are grateful to the Principal, St. Xavier's College, Mumbai; to Mr. M. R. Almeida for help in preparing the paper; Rev. Fr. Conrad Mascarenhas for the Latin diagnosis, to the Director and staff of C.N.H., Calcutta and Botanical Survey of India, Western Circle, Pune, for their co-operation.

■ ■ ■

REVIEWS

1. BATS OF THE INDIAN SUBCONTINENT by J. J. Bates and David L. Harrison pp. xvi + 258, with 8 colour plates. (29.8 cm x 21.0 cm) 1997. Harrison Zoological Museum, Seven Oaks, U.K., price £55.00 (US $ 89).

This is a landmark publication which brings together a comprehensive account of 119 species of bats from every part of the Subcontinent, including the Andaman, Nicobar and Maldive Islands. Hitherto, various studies of Chiroptera from India have been widely scattered, both in time and publication, throughout various zoological journals, including Polish and Hungarian, so that the bibliography alone with over 600 references, taken with the complete coverage in the text, brings virtually all that is known under one cover. But the authors and their team, who actively collaborated with the Bombay Natural History Society, have carried out extensive on-the-spot field investigations, and this book is not solely a museum approach. Their rediscovery of the very rare and local *Oughtomops wroughtoni* and *Latidens salimalii,* with their live photographs, adds excitement to the coverage.

The great strength of this book lies in the detailed anatomical drawings and descriptions under the species accounts, making use of a matrix summary of key characters within each genus, instead of the usual dichotomous keys, which this reviewer has had occasion to compile, whilst becoming increasingly aware of the inadequacy of such a taxonomic approach. Thus there is information for the most meticulous scientific zoologist, while the more generally interested lay person can still glean a wide range of ecological, biological and conservation status information, on species less difficult to identify with certainty. The colour plates, drawings of nose-leafs, appendages, baculae (penis bones) and other anatomical details are especially helpful.

Whilst going through this book, it becomes clear that there are still surprisingly large gaps in our knowledge of many bat species, and indeed I suspect, still some taxonomic confusion due to museum specimens from other collections having been later renamed. The collection localities of such species as *Myotis mystacinus* and *Myotis muricola* from Pakistan (some collected by this reviewer), suggest such a possibility, as also *Murina tubinaris* and *Murina huttoni* within Pakistan.

As everyone closely associated with the Bombay Natural History Society appreciates, getting funding for costly field studies is much harder than carrying out on-the-spot laboratory or museum studies, but I hope that from the undoubted stimulus and interest that this book will produce, young Indian scientists will take up the challenge to find out more about such enigmatic endemic species as *Rhinolophus mitratus, Murina grisea,* and *Epesticus tatei,* which only seem to be known from less than half a dozen old museum specimens.

The inclusion of such a comprehensive Gazetteer is also very helpful, though possibly a little ambitious, covering such a wide region. I notice that Sadikabad in Pakistan is described as located in Baluchistan, while it is in fact in Punjab. Likewise, Peshawar lies in the North West Frontier valley of that name, not in the Punjab Salt Range. These are very minor quibbles, and just handling this book and idly looking at the drawings and species accounts, will fill any reader with both admiration and a desire to possess their own copy.

■ T. J. ROBERTS

2. THE FLORA OF TROMBAY by V. Abraham. Published by Bhabha Atomic Research Centre, Trombay, Mumbai, pp. I-XIV, 1-139 (22 x 14 cm), with 40 plates, 1997. Not priced.

The book contains an account of 528 species of vascular plants belonging to 388 genera and 86 families collected from a stretch of 6 sq. km area of the BARC campus. There are 40 plates (16 coloured and 24 black & white) with 32 coloured photographs, in addition to 43 in black and white.

The book is a welcome publication for two reasons. It gives a glimpse of the rich floral diversity of the region in the heart of Mumbai and it also provides the present status of the vegetation of Mumbai for comparison with earlier records.

As the book is intended mainly to record the biodiversity of the area, this flora does not give descriptions or complete references or keys for the identification of the taxa. The main purpose of the book is to aquaint the reader with the status of vegetation in the area. The book is not a priced publication and will be supplied gratis to those who wish to avail a copy, till stock lasts.

The author possesses a sound taxonomic background and has spent a number of days in Blatter Herbarium. However, due to his discontinuous contact with the latest taxonomic revisions, the book contains some old names which presently have been relegated to synonymy. The nomenclature of at least 20 species needs to be updated in the light of recent taxonomic researches. The number of spelling errors could have been eliminated from this small publication by good proof-reading. We are sure, after R.N. Sutaria's book on 'Systematic Botany' this will attract beginners in Systematic Botany.

■ SANJAY DESHMUKH
■ M.R. ALMEIDA

3. BUILDING BRIDGES FOR CONSERVATION, edited by Ashish Kothari, Farhad Vania, Priya Das, K. Christopher and Sunita Jha. pp 356. (23.8 cm x 18.0 cm) Indian Institute of Public Administration, New Delhi, Price Rs. 200 (hardback), Rs. 100 (paperback).

This fat book is an outcome of a 14-month multi-layered project to study the ways and means to involve local people in the conservation of biodiversity. The major study areas were Dalma Sanctuary in Bihar, Rajaji National Park in Uttar Pradesh and Kailadevi Sanctuary in Rajasthan. It is divided in to ten chapters (called documents). Each document or chapter is semi-independent, with its introduction, methodology, profile of the study area; impact of local people on protected area, impact of protected area on local communities and so on. This book (I think it is more appropriate to call it a report) makes tedious reading with trivial details, list of participants of workshop (p. 100), names of district officers, annexures and source of information. All this may be important for a report but certainly not for a book, which is meant for a wider readership.

'New Directions for India's Wildlife Legislation' (chapter 6) and 'Protected Areas in India: Proposal for an expanded system of categories' (chapter 7) are very thought provoking and I would recommend them to all those who want our wildlife and forests to survive. In order to give these chapters wider publicity, the Indian Institute of Public Administration should print them separately in the form of booklets.

Considering the bulk of the book, the price is reasonable. Buy it for the two chapters mentioned above.

■ ASAD R. RAHMANI

4. BIRDS OF HILL REGION OF KARNATAKA: AN INTRODUCTION by A.K. Chakravarthy and K.P. Purna Chandra Tejasvi. 1992. Navbharath Enterprises, Bangalore. 148 pages with colour and black & white photographs and figures. (21.8 cm x 14.1 cm), price not stated.

A great deal of time, thought and effort has gone into producing this handy guide to the birds and environment of the Malnad region of Karnataka. It is ample evidence of the interest that non-professionals are now taking in the wildlife of this habitat and fauna-diverse region, a situation that bodes well for the future. The book is based on several surveys in various parts of this region, conducted systematically over three years, and more informally through casual birdwatching forays over a longer period.

The authors have made a useful attempt at quantification and graphical representation of some of their bird census data. I believe that this is one of the first times that such analysis has been attempted in an Indian publication outside the realm of scientific journals, and is an excellent example of the way in which amateur birdwatchers can usefully contribute to the growing field of ornithology in the country. The more than two dozen colour and black-and-white photographs are of exceptional quality, and add greatly to the value of this work.

A few minor modifications might be useful in future editions. The structure of the three classes of Frequency of Occurrence have ranges that are perhaps too wide to be of much use in future comparisons with this work. Species descriptions are often too general for an uninitiated birdwatcher to use in definite identification (for example, there is no reference to size). On p. 14, conservation biology should be not only the preservation of gene pools, but a multidisciplinary, extremely interactive field that encompasses the entire spectrum of descriptive, conceptual and analytical tools developed by the natural sciences. Some references are quoted in full in the text (several on p 13), while others appear in the References section. This inconsistency takes away much from the value of the bibliography, and should be attended to in the next edition. Many references to papers cited have been carelessly listed. For e.g. Davison's paper in *Stray Feathers* (x : 329) is quoted with an erroneous title; the volume number and year for Sálim Ali's BIRDS OF MYSORE are incorrect. Such mistakes not only take away from the value of this otherwise interesting and apparently well researched book, but make one wonder whether the authors have really looked at the papers they cite. The last page of the book contains what for me is the greatest disappointment of this book : a suggestion to birdwatchers in the area that because ''an amateur often finds it difficult to even focus on smaller birds feeding actively...an air rifle becomes handy for such situations." I believe that this is a retrogressive step, evolving from a refusal to accept the tremendous leap in field identification of birds that are currently underway, with the appearance of new, brilliantly illustrated field guides. It is this 'movement' aimed at enhancing identification skills that amateurs should be encouraged to join, rather than going back five decades when the only way to identify most birds was to shoot them down. The book is a welcome change from the standard regional checklist, and birdwatchers in the region would greatly benefit by comparing their own notes with it.

■ SHAHID ALI

5. WATERFOWL POPULATION ESTIMATES, 2nd Edn by P. M. Rose and D. A. Scott. Wetlands International Publication 11, The Netherlands, 1997. pp 106.

Wetlands International, created in 1996 by the integration of the International Waterfowl and Wetlands Research Bureau, the Asian Wetland Bureau and Wetlands for the Americas, is in the forefront for protection of wetlands and waterfowl. The Wetlands International (WI) is quick in dissemination of data if it helps in better protection of wetlands and waterfowl. Sometimes the data is too scanty or inadequate to be of any use. In the second edition of their highly popular document, Rose and Scott have attempted to collate the data on all the species of birds dependent on wetlands. The book is in the form of a long research paper, with Introduction, Methodology, Results, Discussion, Acknowledgements and References.

As new information keeps appearing and old data have to be updated, a book of this nature has to be a ''working document subject to periodic revision". The WI plans to update this document every three years. The second edition is like the first edition in general design, only population data are updated.

As the blurb of the book indicates, Rose and Scott have identified 1,924 distinct biogeographic populations of waterfowl from 840 species world wide. Numerical estimates of at least one population of 641 species and the population trends have been given. They have also identified gaps in knowledge at both taxonomic and regional levels. All water-dependent species from Gaviidae (Divers), Podicipedidae (Grebes) to Rhynchopidae (Skimmers) have been described in tabulated form: species and subspecies, population and distribution, Ramsar regions, population estimate and population trend. Even species or groups such as Stone Curlew (Burhinidae), Least Seedsnipe (Thinocoridae) and Plains-wanderer (Pedionomidae) which are dryland birds have been included due to their closeness to waders. But despite the fact that some raptors are totally dependent on wetlands (e.g. Osprey, White-tailed Sea-Eagle, Pallas's Fish Eagle), they are excluded. Perhaps a separate document about the raptors of wetlands should be brought out.

Frequent gaps in the population data of most species proves how little we know about our waterfowl. The annual Waterfowl Count has generated a lot of interest among Indian ornithologists. This publication drives home the point that much more work has to be done to save our wetlands and waterfowl. I recommend this book to all who are interested in the protection of wetlands and waterfowl.

■ ASAD R. RAHMANI

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MISCELLANEOUS NOTES

1. ON THE SCALES OF THE SCALY ANTEATER *MANIS CRASSICAUDATA*

(*With three text-figures*)

The present study is mainly based on specimens examined during routine field work on the Indian pangolin *Manis crassicaudata* to study its ecological aspects. The scales are composed of agglutinated hairs (Jerdon 1874). They are, in fact, enormously enlarged and flattened hairs or spines of the body (Roy 1949, Prater 1971). The scales are not "glued hairs" as was once believed, but are two sided symmetrical elevations of the epidermis. The horny scales which are lost through wear are constantly replaced by growth from the epidermis.

Externally, the pangolin appears hairless, as scales are present all over the upper part of its body except on the snout, chin, sides of the face, throat, belly and inner surface of limbs. Variation has been noticed in the shape, texture, colour, number, size and weight of the scales.

Interestingly, as a protective measure, the animal curls itself into a ball whenever in danger. This rolling posture provides a more rigid and sharp cutting edge because of the imbricate arrangement of the scales, that creates a gap between rows of scales and presents a shape like the spokes of a wheel (Fig. 1b).

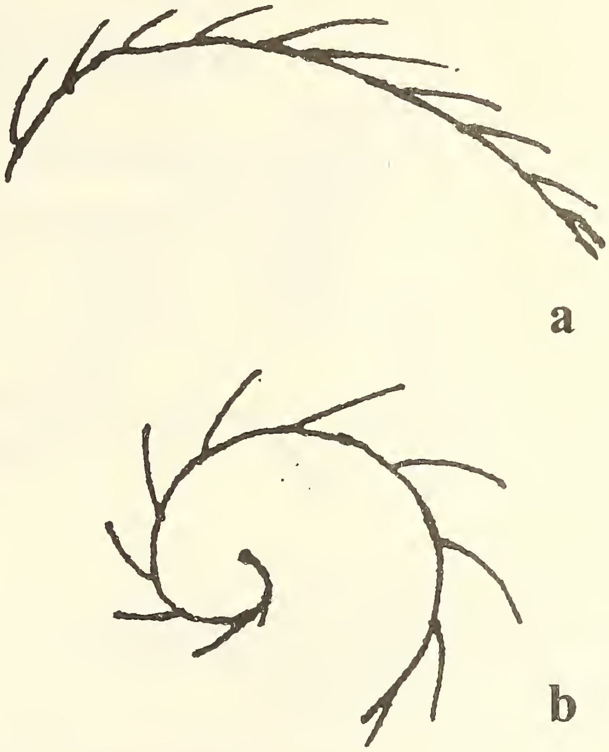
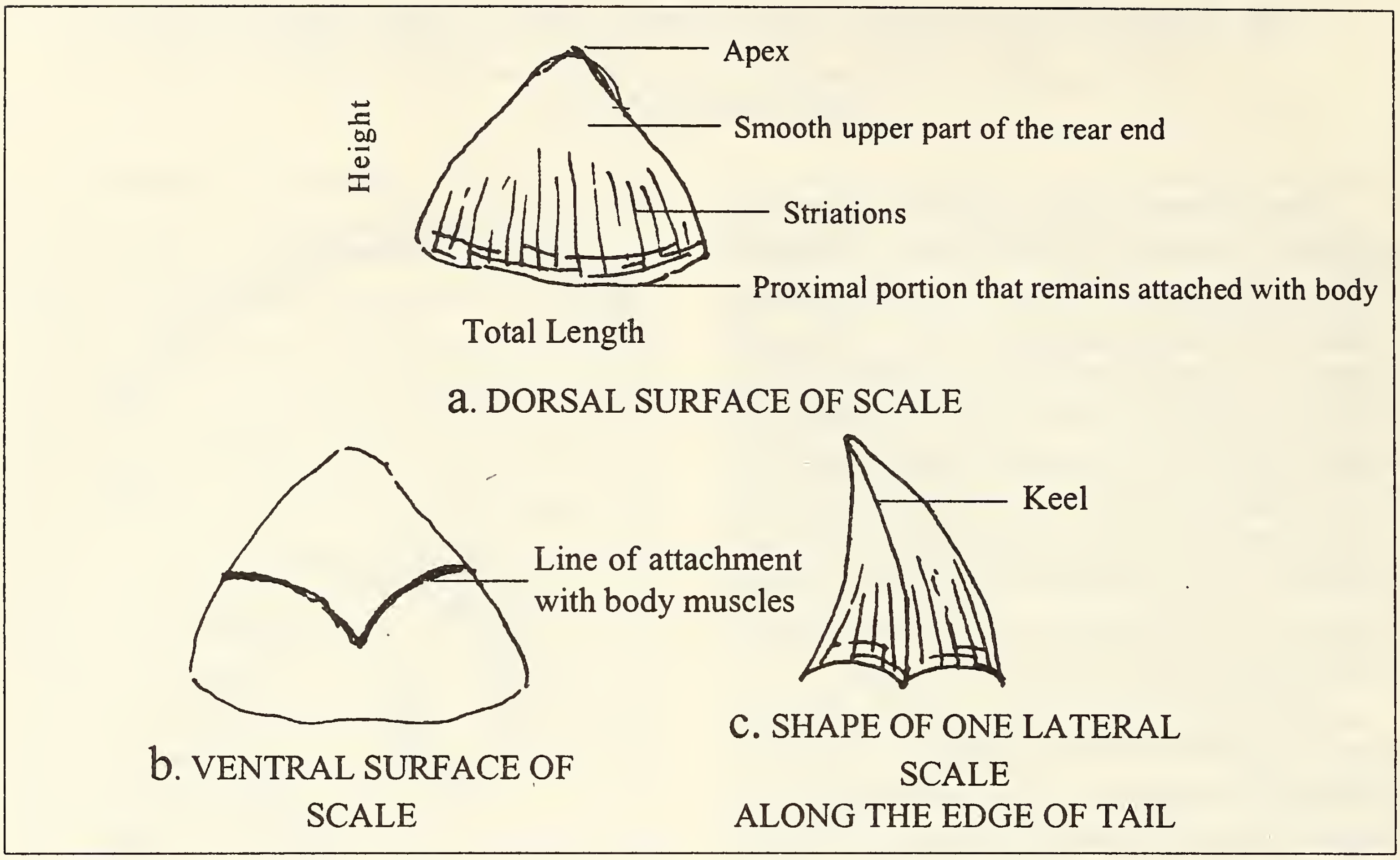


Fig. 1: Scale arrangement on body surface: a. in normal posture; b. in rolling posture

I noticed that the pangolin is highly sensitive and can even feel a little touch on the hard scales by hand or any other object. It immediately tightens all the scales side by side to make a compact ball. In the coiled state, its head remains safe inside the innermost whorl.

Histologically, epidermal cornification at the tips of the dermal papillae leads to the formation of hard scales (Rahm and Thenius, 1988). I observed that the scales on the dorsal side of the pangolin's body are more or less triangular, with a broad base and narrow apex, while some are blunt on both sides and comparatively smaller in size. Scales are usually dorso-ventrally flattened, but a few scales (Fig. 2c) appear pyramidal along the tail line. Fine striations are visible dorsally at the lower or proximal half of the scale which remains attached to the body, but the distal end that projects outwards presents a smooth upper surface (Fig. 2a). A line marking the attachment site for body muscles can be identified easily on the ventral surface of the scale, (Fig. 2b) which is pale coloured.

The present study carried out in different ecological conditions showed that the pangolin, being a nocturnal creature, generally comes out and remains active at night, but has also been seen in the daytime on several occasions, when a cryptic body colouration can save it from predatory and human interference. Its body hairs are hardly visible externally (except in the lower part of the body). So the colour of the scales plays a significant role.


Height
Apex
Smooth upper part of the rear end
Striations
Proximal portion that remains attached with body
Total Length
Line of attachment
with body muscles
Keel

a. DORSAL SURFACE OF SCALE

b. VENTRAL SURFACE OF SCALE

c. SHAPE OF ONE LATERAL SCALE ALONG THE EDGE OF TAIL

Fig. 2: Diagram of scales showing different views

Pangolins of Asian and African origin are generally found in shades of grey, dark brown, olive brown, pale olive, khaki, yellow brown and yellowish (Kingdon 1971, Roberts 1977, Rahm and Thenius 1988, Bing Su, *et al.* 1994). During this study, scales were found to be grey and olive brown, whereas in captivity they looked pale.*

Size and weight of the scales was estimated from isolated scales of full grown or adult animals recovered from various sources. I found that the size of the scale** may vary from 6.5 cm - 7 cm (height) and its average breadth is 8.5 cm. Each scale weighs 7-10 gm. There is a slight variation in the shape and size of the scales in the Indian species of *Manis*. They are comparatively smaller and darker in *Manis pentadactyla* (Chinese pangolin), and larger and blunt shaped in *Manis crassicaudata* (Indian pangolin). The Indian pangolin may have about 160-200 scales all over the body, of which 40-46% are present on the tail. It is believed that the pangolin has the same number of scales throughout its life.

Chemical analysis of the scales reveals that they contain a considerable amount of scleroprotein, which needs a lot of protein intake from external sources, though the relationship between food preference and accumulation of this protein has not yet been established. The animal pays a heavy price for its defensive armature of scales.

Total protein content (in 100 gms of sample) =
amount of nitrogen estimated x conversion factor***
Result: protein content, percent/mass =88.4

The major use of pangolin scales is in traditional medicine, and they can be obtained

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* Recently, workers from China, have identified two forms of pangolin without giving them any formal names.

** They were mostly taken from the dorsal and tail regions of the animal's body.

*** Conversion factor of 6.25 has been used for estimating the quantity of crude protein from total nitrogen content.

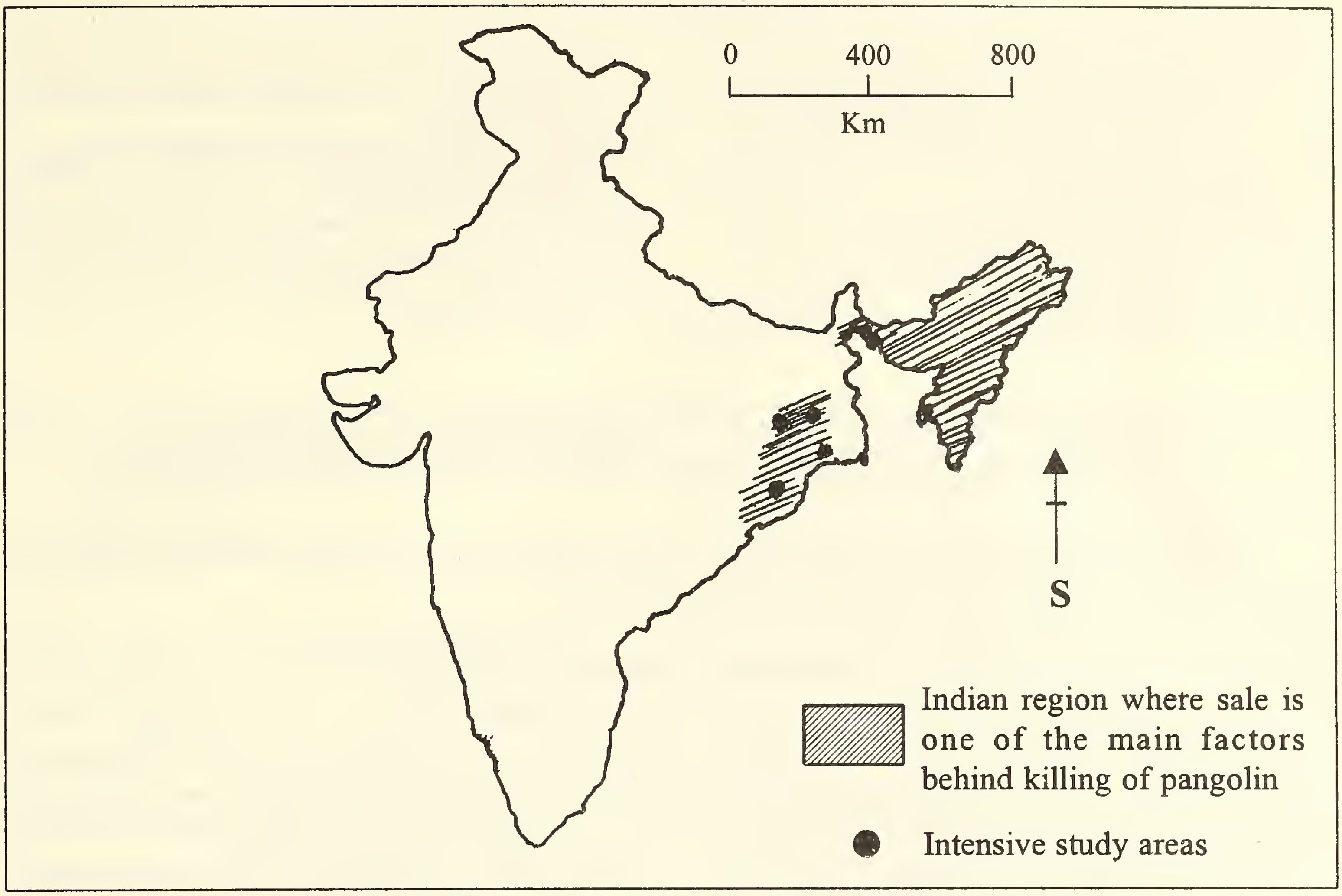
0
400
800
Km
S
Indian region where sale is one of the main factors behind killing of pangolin
Intensive study areas

Fig. 3: Map showing study areas

from traditional medicine sellers of China, Nepal, Malaysia, Korea and many southeast Asian countries including India. During the study, I questioned the local inhabitants about the use of these scales in their society. A few samples were purchased from the tribals who kept them for medicinal purposes.

The following are a few examples of popular beliefs I came across during my field work in the study areas: Scales are used as magical charms. They help to bring good luck. They are a curative for piles, and also used for treating toxicosis, inflammation, rheumatic pain and scabies.

A growing interest in the scales has been noticed among Asian and European buyers for the supposedly curative effect on breast cancer (Nash 1992). Price varies in different parts of the world but genuine information related to the trade of the Indian pangolin is not substantial. In the open market, a dozen scales may cost Rs. 50-60 or more, from my experience.

Scales are generally associated with fish, reptiles and to some extent birds, but are very unusual among mammals. However, much is yet to be discovered.

ACKNOWLEDGEMENT

I thank the Forest Departments of West Bengal, Orissa, Tripura and Bihar for permission to carry out field work during my study. Special thanks go to the Zoological Survey of India for support.

January 1, 1998

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2. EVIDENCE OF CLOUDED LEOPARD *NEOFELIS NEBULOSA* IN PAKHUI WILDLIFE SANCTUARY, ARUNACHAL PRADESH

During a field project from November 1995 to April 1996 on arboreal mammals in Pakhui Wildlife Sanctuary (WLS) (92° 7.5' E - 92° 22' E and 26° 53.7' N - 27° 16.2' N), East Kameng dist., W. Arunachal Pradesh, in northeast India, I came across the carcass of a clouded leopard *Neofelis nebulosa*. The carcass was about 2-3 months old. It consisted of the entire skeleton of the animal (except the skull) along with parts of its skin, one front and one hind limb with the paws and skin covering intact. Clumps of fur and whiskers were also present. Most of the carcass had already rotted and was infested with maggots. At the same spot, the remains of a wild pig were present. The carcass was found in a secondary forest 300-400 m from the forest department colony at Seijusa, and 150 m from an unmetalled forest road used frequently by the forest dept. staff and captive elephants. This area was located near the sanctuary's southern boundary with Assam, very near human habitation. A clouded leopard was sighted about 1 km from Seijusa in reserved forests at the border of Arunachal Pradesh and Assam by Shri Pratap Singh, IFS (a forest officer from Arunachal Pradesh Forest Dept.) in 1994. Athreya and Johnsingh (1995) found evidence of its presence in the area with local tribal hunters in 1994-95, though no photographic evidence of a live animal could be obtained. Two male clouded leopard cubs were found in forests of the Lower Subansiri dist. in 1995, which are now at Itanagar Zoo (Dey 1995).

The dead animal's paws which were slightly distorted were 5.7 cm in length and 5.5 cm in width. Athreya and Johnsingh (1995) reported average length and width of pugmarks from 4 captive clouded leopards as 5.6 cm and 6 cm, respectively. The tail length was 81 cm. Walker (1975) reports that the tail length of the clouded leopard ranges from 61 to 91 cm. The head was missing, the length from the neck vertebrae to the base of the tail was 66 cm. The length of the hind limb was 52 cm. The shoulder height of the clouded leopard is reported to be about 80 cm (Walker 1975). The whiskers and hair samples of the animal were collected.

Pakhui WLS, with an area of 862 sq. km, is well-protected on its northern and western boundaries by the Bhareli river, to the east by the Pakke river, and is contiguous with Papum Reserve Forest of Khellong Forest Division. To the south lie the reserved forests of Assam. Only a small area, where the carcass was found, near the southeast boundary is disturbed, otherwise the vast inner areas of the sanctuary bear excellent undisturbed forests. There are no settlements inside, except for one or two small ones at the extreme northern boundary. A village on the southeastern boundary has been relocated outside the sanctuary. The lack of many trails and general inaccessibility has helped in preserving the sanctuary. A proposal has been mooted to declare Pakhui a national park.

I have also seen the jaws of several clouded leopards and tigers, a skin and skull of a leopard cat and another stuffed specimen with tribals in this area. Tracks of tigers, leopards and smaller cats were seen occasionally along trails and on river beds, both in the adjacent reserved forests and in the Sanctuary.

June 29, 1998

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3. *DUGONG DUGONG* IN THE GULF OF KACHCHH

On February 9, 1998, I conducted my annual "Showing of the Flag" among the islands of the Gulf of Kachchh. At about 1130 h, some 45 minutes walk from the Centre for Environment Education (CEE), Ahmedabad's Nature Education Camp on Beyt, and approaching the rocky reefs and sandbars extending north from the Poshita headland, I saw a brown form outlined below the surface of the crystal clear waters. The sea was calm and the bright sun shining from behind. The animal surfaced to breathe and was close enough for me to hear its breath being released. As the flat snout broke the water, followed by the finless back, it looked strangely like a tiny sperm whale! The animal swam along in bucolic fashion, powered by its horizontal, rounded flukes. We could have approached the creature but I decided not to disturb it. It was a large specimen a little over 3 m, judging from the length of the fishing craft we were in alongside it.

It was in the mid eighties that I had found a dead male dugong in these very waters. Dr. Frazier and two post-graduate students from the Biosciences Department, Saurashtra University, Rajkot were fortuitously my guests and they did a detailed dissection of the carcass. It had drowned, apparently having got entangled in a fishing net. There were deep cuts caused by the nylon meshing.

The continued presence of dugongs in these waters adds to the urgency for careful conservation action, even as the Jamnagar coast is witnessing massive industrial development.

February 20, 1998.

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4. WHITE BISON IN CHINNAR

It was Mr. J.L.H. Williams who first reported the occurrence of white gaur in Manjampatti valley and adjoining areas. During the 1930's, he had observed in this area several herds of gaur with unusually coloured individuals whose colour ranged from 'light red through dun to pure white.' Even though the gaur is widely distributed in the Subcontinent, this phenomenon appears to be unique to Manjampatti area. However, since 1940 there have been no reports about these odd coloured gaur. E.R.C. Davidar (1970) set out on a BNHS sponsored mission to find and photograph them, but submitted a negative report. It was presumed that the Rinderpest which ravaged this area had wiped them out.

Recently, two herds of gaur with three greyish white individuals were observed in Chinnar Wildlife Sanctuary in Idukki dist., Kerala. Chinnar is contiguous with Manjampatti Valley. On Oct. 21, 1997, at 1810 h, two greyish white gaur, an adult female and a sub-adult were observed on the slopes of Cheevaparamala along with nine other gaur. A juvenile of the same colour was found at Koottar on January 3, 1998 along with five other animals. The typical white stockings are not distinguishable on these greyish white gaur. Interestingly, the colour of the majority of the animals in these herds ranges from brick red to light red. In the first herd of eleven gaur there were only four normal coloured individuals and in the second herd two, including a magnificent black bull. These herds are extremely wary, and bolt at the first whiff of human scent. This is the first record of White Bison from Chinnar Wildlife Sanctuary.

March 3, 1998

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5. FIVE STRIPED SQUIRREL *FUNAMBULUS PENNANTI* OBSERVED EATING HONEY

(*With one plate*)

I had been to Bigwan to photograph flamingoes and on the way to Dalaz No. 2 village, I noticed that on a tall Acacia tree there were three beehives. Two beehives were full of wasps and one beehive was abandoned. To my surprise, I saw a five striped squirrel *Funambulus pennanti* moving up and down the beehive. I watched through my binoculars and to my surprise, I found the squirrel nibbling at the beehive and licking the honey as it started flowing out. It was astonishing that the wasps on the hive and on the other two beehives did not attack the squirrel. I have read of the honey buzzard, honey bird and the badger eating honey. The above observation could be the first record of a squirrel feeding on honey from a hive with wasps. It is possible that the wasps drove away the bees from the nest

September 29, 1997

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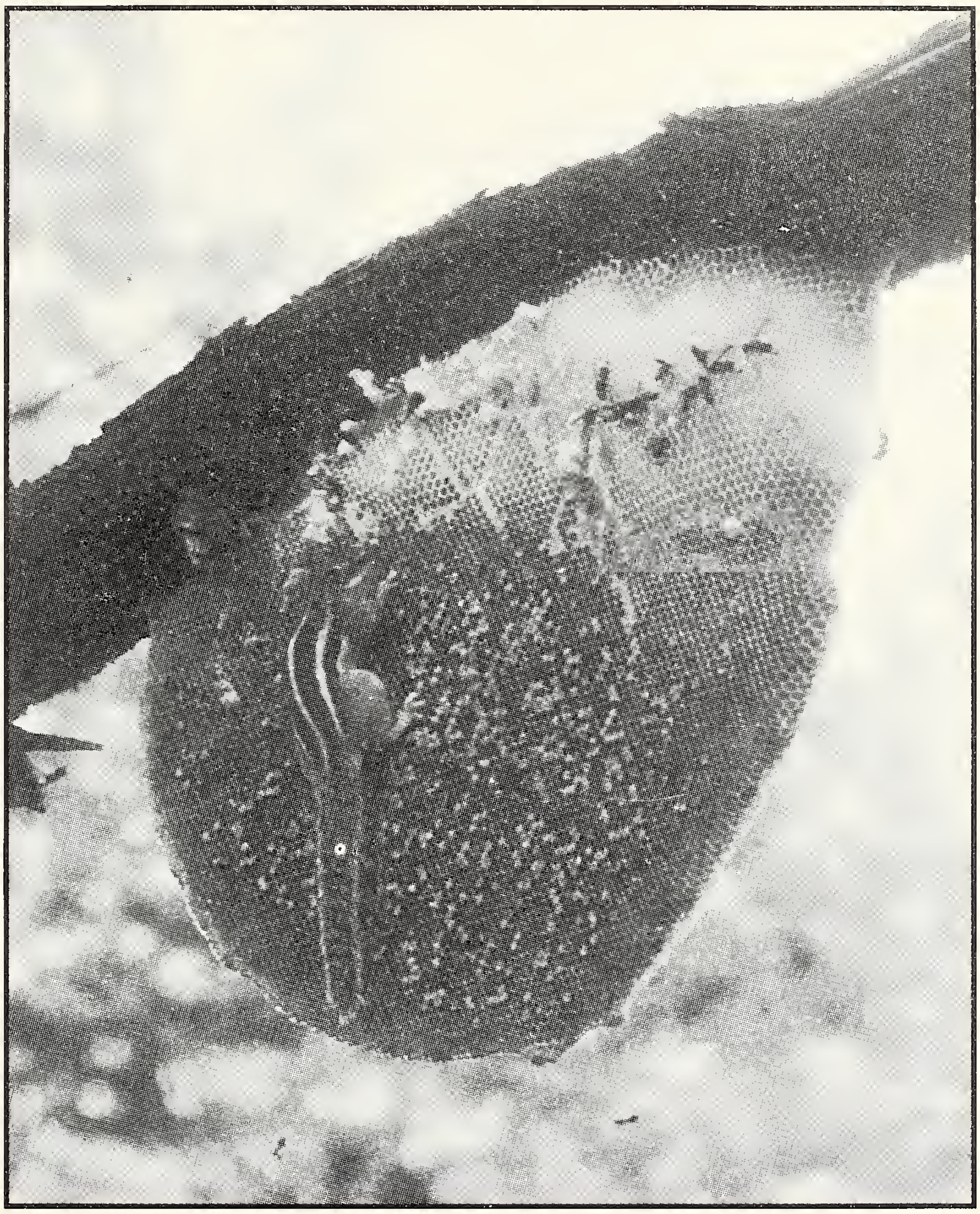
Sattyasheel N. Naik: *Funambulus pennanti* PLATE 1



Funambulus pennanti eating honey

6. USE OF CATTLE EGRET *BUBULCUS IBIS* ORGANS AS MEDICINE

On September 3, 1995, a person was caught capturing subadult chicks from the nests of Cattle Egret *Bubulcus ibis* in a heronry, near my residence at Raipur, Madhya Pradesh. He had collected four chicks by climbing the trees. On interrogation, he revealed that the liver is taken out after killing the birds. This organ is dried, powdered and mixed with other ingredients to prepare medicine as a cure for asthma. Adult birds are also captured, but it is more difficult to capture them and hence, collection of subadult birds from nests is preferred.

This is yet another instance of the killing of birds for medicinal purposes. The scientific basis for this practice needs to be ascertained to curb killing on this account.

March 22, 1996 A.M.K. BHAROS
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7. SIGHTINGS OF LESSER FLORICAN *SYPHEOTIDES INDICA* (J.F. MILLER) FROM MEDAK, ANDHRA PRADESH

The endemic and endangered lesser florican *Sypheotides indica* (J.F. Miller) is a rare bird in Andhra Pradesh, with barely a few sightings over a period of one hundred years (Sankaran *et al.* 1992). It has been reported in recent years from around Hyderabad city (Taher pers. comm.), Medak dist. (Taher 1984) and from Rollapadu Wildlife Sanctuary in Nellore dist. (Manakadan and Rahmani 1990, 1993; Sankaran and Manakadan 1990, Rao 1994). Andhra Pradesh is the southernmost Indian state where the Lesser Florican is found today. It is known to breed in Rollapadu Wildlife Sanctuary, during years of severe drought conditions in its traditional breeding grounds of Gujarat and Madhya Pradesh (Sankaran and Manakadan 1990). The precarious population level of this bustard in India, estimated at a mere 750 birds in 1989 (Sankaran *et al.* 1992) merits grave concern and should be viewed seriously by conservationists and wildlife planners in the country. Every record of the bird, whether new or a confirmation of existing data, is significant.

On March 31, 1997, an immature lesser florican was seen on the campus of ICRISAT Asia Center (17° 30' N, 78° 15' E), Patancheru, Medak dist., by a member of the Birdwatcher's Society of Andhra Pradesh (C.T.H.). He was in a field of *bajra* (*Pennisetum glaucum*) at 1000 h, when the bird flew up and settled in an area of *jowar* (*Sorghum bicolor*), groundnut (*Arachis hypogea*), and chickpea (*Cicer arietinum*) fields some 150 m away. When informed of this sighting, we drove down to ICRISAT on the morning of April 6, 1997, to try to spot the bird and confirm it. After a brief search, we saw the bird fly up once again from a chickpea field in the same area! On attaining a height of *c.* 10 m, it turned in a wide semi-circle and disappeared to the west over some trees and buildings. As the bird rose, it hit an overhead wire, scattering a few feathers. It is pertinent to note here that in October 1984 (Taher pers. comm.), a female lesser florican was caught in a residential area of Hyderabad city in the evening, after it collided with an overhead wire and fell into the garden of a house, where it was rescued in the nick of time from the family dog!. This bird had a fresh injury on its breast, a horizontal bruise clearly a result of the collision. It was subsequently handed over to the Nehru Zoological Park authorities in Hyderabad, where it died a few days later. Do overhead wires pose a threat to this bird of open grasslands during its movements within the country?

Another bird was reported from near Siddipet in Dubak Mandal, Medak dist., by the DFO, Mr. Shankaran (pers. comm.), who had positive information of a villager having caught it (February 26, 1997) and kept it for a couple of days before the Forest Department staff released the bird.

ACKNOWLEDGEMENTS

We thank the management and staff of ICRISAT Asia Center for permitting us to birdwatch within the campus. We also thank Mr. Shankaran, DFO, APFD for information.

June 27, 1997

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8. OCCURRENCE OF REDBREASTED PARAKEET *PSITTACULA ALEXANDRI* IN MUMBAI, MAHARASHTRA

The Indian Redbreasted parakeet (*Psittacula alexandri*) is distributed in the lower Himalayas (*terai, bhabar*, and up to *c.* 1500 m) from about Dehra Dun (Kumaon) eastward through Nepal, Sikkim, Bhutan and Arunachal Pradesh, south to Assam, Nagaland, Manipur and Mizoram(?), Bangladesh (Ali and Ripley 1969 HANDBOOK OF BIRDS OF INDIA AND PAKISTAN, Vol. 3: 172). It is a resident bird with some local nomadic movement depending upon the food supply. It is found in moist deciduous biotope - thin secondary jungle and in the neighbourhood of shifting cultivation. It generally avoids dense evergreen forests. Like other parakeets, the Indian redbreasted parakeet is a popular cage bird. It is regularly sold in Crawford market in Mumbai (Rajat Bhargava and A.R. Rahmani, 1997, pers. comm.).

In April 1994, I was surprised to see two birds on an Indian champ (*Michelia champaca*) tree in Andheri (West), a densely populated suburb of Mumbai. They must certainly have been cage escapees. After a gap of about one month, I managed to trace their roost on closely clustered *Artocarpus heterophyllus, Syzygium cumini* and *Mangifera indica* trees on a busy street of Andheri. There were nine parakeets which shared this roosting site with other species viz., *Corvus splendens, Columba livia* and *Passer domesticus.*

Three years after my first observation, in May 1997, the flock had increased to 15 individuals. One of the most interesting observations was that of a bird entering a hole in a wall at a height of 15 m. Perhaps these parakeets have started breeding in the Mumbai region.

Near Mumbai, an excellent patch of forest exists in Sanjay Gandhi National Park (SGNP), which is linked to the Western Ghats through other forest patches of Tungareshwar, Matheran and Lonavala. It is likely that the redbreasted parakeet will establish itself and may even spread through the Western Ghats. If so, it will be interesting to study the repercussion on the local birds.

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9. SIGHTING OF HODGSON'S FROGMOUTH *BATRACHOSTOMUS HODGSONI HODGSONI* (G.R. GRAY) FROM SIKKIM

The Hodgson's Frogmouth *Batrachostomus hodgsoni* has been recorded as very rare in Sikkim. Found in the Great Rangit Valley by Hodgson and at Namchi (*c.* 1500 m altitude) by Mandelli (Ali, 1962 THE BIRDS OF SIKKIM, OUP) over a hundred years ago, it was not recorded by by Ali (1962) during his visit to Sikkim in 1955.

On November 30, 1994 at around 1100 h one male frogmouth was sighted at Pabong about 4-5 km from Singtam (*c.* 500 m) on the way to Namchi, by the second author, a forest officer and keen local birdwatcher. The bird flew down and alighted about 6 m from the jeep, beside the road at the turning just above Pabong River.

The area is a relatively undisturbed patch of evergreen forest of *Schima wallichi* and *Dyxozylum* sp. In September-October 1996, the area was visited briefly in connection with a lowland forest survey. The entire lower stretches of the Teesta and Rangit Valleys (450-500 m.) were surveyed, but in both areas the species was not sighted. Hence the above sighting was a lucky encounter with this very rare species.

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10. WOODPECKERS FEEDING ON *CASSIA* PODS

Cassia fistula is a fairly common tree at the Peechi-Vazhani Wildlife Sanctuary (WLS), its long cylindrical pods are characteristic of this tree. On several occasions, all through my study (1991-1993), I found two species of woodpeckers — Mahratta (*Picoides mahrattensis*) and Heartspotted (*Hemicircus canente*) associating with the pods of this tree. They were seen pecking the dry, dark-coloured pods and often spent several minutes at a stretch on these pods. Several pods were noticed with a series of holes in them. The birds appeared to avoid the green, fresh pods and concentrated on the drier dark pods. Curious to find out what was attracting the birds to the pods, I collected some and broke them open. I discovered tiny larvae in two of the pods. I handed over these specimens to Dr. George Mathew, Entomologist, Kerala Forest Research Institute, Peechi, who reared them and found them to be larvae of a micro-lepidopteran species, which could not be identified. This indicated that the birds were not pecking at the pods for their pith, as I had earlier suspected.

Ganguli (1975) had earlier reported that Mahratta woodpeckers had made holes in all the dry *Cassia fistula* pods in her garden in New Delhi, but was not sure if it was for the pith or for insects. Balasubramanian (1991) had reported redvented bulbuls (*Pycnonotus cafer*) pecking at pods of *Cassia fistula* at Point Calimere and suggested they did so to feed on the pulp of the pods.

ACKNOWLEDGEMENT

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February 28, 1997

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11. DRUMMING FREQUENCY IN WOODPECKERS

Drumming is extensively used by woodpeckers in the social context, to announce their territories and locate potential mates (Short LL. 1982 WOODPECKERS OF THE WORLD, Delware Museum of Natural History). However, as most species maintain territories round the year, they may resort to this instrumental signalling throughout the year. I have recorded the drumming of woodpeckers at my study site in Peechi Vazhani Wildlife Sanctuary from September 1991 to May 1992 (see Table 1).

TABLE 1

DRUMMING FREQUENCY OF WOODPECKERS IN DIFFERENT MONTHS

Month	Days	PY	MA	HS	YN	SB	RU	GB	MG	UN
Sep.	21	2	-	2	1	1	2	-	9	8
Oct.	21	1	-	-	-	-	2	1	13	5
Nov.	11	1	-	-	-	-	2	-	3	5
Dec.	22	5	4	-	-	-	7	1	3	3
Jan.	31	6	3	-	-	-	1	3	2	16
Feb.	22	2	3	-	-	2	6	1	7	2
Mar.	23	2	3	-	-	2	-	-	4	12
Apr.	22	1	-	-	-	2	2	4	9	4
May	22	-	-	-	-	2	2	3	6	9
Total	195	20	13	2	1	9	24	13	56	64

PY : *Picoides nanus*
MA : *Picoides mahrattensis*
HS : *Hemicircus canente*
YN : *Picus chlorolophus*
UN : Unidentified
SB : *Picus xanthopygaeus*
RU : *Celeus brachyurus*
GB : *Dinopium benghalense*
MG : *Chrysocolaptes lucidus*

The table shows the number of days on which drumming was recorded. From this, it is evident that the large goldenbacked woodpecker (*Chrysocolaptes lucidus*) and rufous woodpecker (*Celeus brachyurus*) were the most consistent drummers, followed by pygmy woodpeckers (*Picoides nanus*), in terms of total number of days and months in which drumming was recorded. Two species - Mahratta (*Picoides mahrattensis*) and little scalybellied (*Picus xanthopygaeus*) woodpeckers appeared to concentrate their drumming activities in their respective breeding seasons.

Though distinct in some species, drumming is similar for several species and at times indistinguishable. This accounts for a good number of drummings that could not be identified to the species level. For two species - heartspotted woodpecker (*Hemicircus canente*) and lesser yellownaped woodpecker (*Picus chlorolophus*), fewer instances of drumming were recorded. In the heartspotted, I have reported elsewhere that drumming is not common and is perhaps substituted by duetting calls. It is also possible that some of the low volume drumming was missed due to poor audibility. Yet the drumming of the pygmy woodpecker, which is brief and inaudible at a distance, was recorded quite frequently.

On two occasions, I came across two species of woodpeckers engaged in long bouts of drumming. Firstly, on January 13, 1992, a pygmy woodpecker was noticed drumming on a dead branch of *Grewia tilaefolia* from 1146 - 1203 h, with a brief interval of 2 minutes for preening. For a period totalling 4 minutes 25 sec, I recorded 72 bouts of random drumming and for the entire session, the bird could have drummed 243 times. On several other occasions, I have heard the birds drumming more briefly, about 5-20 times each. The second occasion concerns the Mahratta woodpecker, which drummed for a period of 14 minutes (1013-1027 h) on March 16, 1992, on a dead teak (*Tectona grandis*) branch. Random counts for a period of 5 minutes showed the bird drumming on 69 occasions and for the total period the bird could have drummed 196 times.

Short (*Ibid.*) says that longer bursts of drumming could be heard during the time that birds are establishing territories or while engaged in courtship, when a new mate is being attracted.

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12. RANGE EXTENSION OF THE GREEN SHRIKE-BABBLER *PTERUTHIUS XANTHOCHLORIS* IN PAKISTAN

The green shrike-babbler *Pteruthius xanthochloris* occurs in Himalayan moist broad-leaved and mixed coniferous forest, seasonally between 1,200 m and 3,000 m (Roberts 1992). Ali and Ripley (1972) and Inskipp and Inskipp (1985) state that the species occurs eastwards from the Murree Hills, Punjab, Pakistan to Arunachal Pradesh. Roberts (1992) notes that the western limit of the species' range is based solely on a breeding record from the Murree Hills at 2,400 m in July 1900. There have been no subsequent records of green shrike-babbler from the Murree Hills and Roberts (1992) speculates that the species is extinct there, summarising that the species is "rare" in Pakistan.

During January 28-30, 1995, we spent two days birdwatching in the Murree Hills between Dunga Gali and Murree town. On January 29 we were in the Dunga Gali area at approximately 2,200 m altitude. Mixed flocks of birds, largely comprising of tit species Paridae, goldcrests *Regulus regulus*, and white-cheeked nuthatches *Sitta leucopsis*, were frequently encountered foraging in the open, mixed forest. At 1230 h we stopped to watch an orange bullfinch *Pyrrhula aurantiaca* amongst one such flock. As the birds moved through, a green shrike-babbler was located in mid canopy. We observed the bird for around three minutes before it moved on with the goldcrests. It was foraging unobtrusively in a manner reminiscent of a red-breasted flycatcher *Ficedula parva*, perching in evergreen oak *Quercus* sp. foliage and occasionally flitting to take prey.

Four weeks later, on February 23, 1995, whilst undertaking surveys of the western tragopan *Tragopan melanocephalus* in the Palas Valley, Indus Kohistan, we encountered another green shrike-babbler. The bird was feeding alone in the canopy of evergreen oak forest at 1,900 m, foraging in a fashion similar to the individual seen earlier.

These observations confirm that the species still occurs in the Murree Hills, and extend the western limit of its known range into Indus Kohistan.

ACKNOWLEDGEMENTS

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13. WESTERN GREYHEADED THRUSH *TURDUS RUBROCANUS RUBROCANUS* G.R. GRAY IN SIKKIM

A male western greyheaded thrush *Turdus rubrocanus rubrocanus* G.R. Gray was seen foraging in a freshly sown maize field at Forest Colony, Baluakhani, Gangtok (1800 m) on the morning of March 30, 1989. It was observed for ten minutes from a distance of *c.* 6 m.

On being disturbed by my trying to get closer, it stood motionless for more than four minutes. When another person arrived, it hopped off *c.* 12 m away down the terraced field to the feeding territory of the resident greybacked shrike *Lanius tephronotus*, which promptly chased it almost 60 m away. We could see it foraging in that field until some children came out to play. It then flew out of sight.

There is only one record of this bird from Sikkim, by Dr. B. Biswas on January 7, 1953 at Kewzing *c.* 1700 m (Ali 1962, THE BIRDS OF SIKKIM, OUP). On May 3, 1912, one female was collected by Stevens from the Singalila Ridge (3000 m) in Darjeeling (Ali 1962) now in West Bengal. These two records give the easternmost breeding limit for the species.

After the 1989 sighting, attempts were made to look for the bird in all other areas as well, but so far without success.

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14. NESTING SITES OF HOUSE SPARROW *PASSER DOMESTICUS*

On September 4, 1996, along the Vastana roadside in Matar tehsil, Kheda dist., Gujarat, we saw a pair of house sparrows *Passer domesticus* nesting below the nest of some large bird (probably an abandoned nest of house crow), with the support of the electric pole edge. The location of the pole was away from the village, along the road passing through the paddy fields. Nesting material was seen to be collected by the male sparrow from the roadside, on September 4 and 5, 1996, at noon. A similar nest location was recorded at Bamroli village in Nadiad tehsil, in the same district. The sparrow had made its nests below the nest of Whitenecked Stork *Ciconia episcopus* on a neem tree *Azadirachta indica*.

Though the whitethroated munia *Lonchura malabarica* is known to build its nest below the nest platform of some large birds (Parasharya 1982, Ali and Ripley 1983), the Indian house sparrow *Passer domesticus indicus* is not known to show such behaviour (Ali and Ripley 1983, Mathew 1987). The house sparrow in Britain is known to nest in the walls of the active nests of large birds, particularly rooks *Corvus frugilegus* and magpie *Pica pica;* and in other European countries with nests of stork and birds of prey (Summer-Smith 1963). The present record confirms this behaviour in the Indian subspecies. A nest on an electric pole at least 2 km away from the village (human habitation) is an additional adaptation to exploit abundant food supply — a tendency towards independent existence but with extensive protection.

March 21, 1997

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15. SOUTHERN BLACKHEADED MUNIA *LONCHURA MALACCA MALACCA* IN KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN

On November 12, 1996, a small flock of 5-6 southern blackheaded munia (*Lonchura malacca malacca*) was spotted feeding in a reed patch alongside a stream in Koladher area of the Keoladeo National Park in Bharatpur, Rajasthan. Koladher is a grassland with scrub and acacia trees.

The munias were in black and white plumage, with white underparts. Acccording to Ali and Ripley (1983), out of three races of *Lonchura malacca*, only the southern race *L. m. malacca* has white underparts. The other two subspecies *L.m. rubriniger* and *L.m. atricipala* have rufous underparts and are distinguishable in the field from *L.m. malacca.* Vijayan (1991) reporting on the study conducted at Bharatpur from 1980-90 does not record this species. Abdulali and Pandey (1978) listed this species as a stray, without specifying the subspecies. Vyas (1996) recorded having seen a flock of 20 birds at Madanpur, Delhi on July 6, 1996, but did not specify the plumage details to enable recognition of the subspecies. Since the flock was seen in the typical habitat some distance away from any large city, the chances of these birds being an escape population does not seem possible.

According to Ali and Ripley (1983), the subspecies *L.m. rubriniger* is found from Himalayan duns, terai and plains of Uttar Pradesh eastwards to eastern Nepal and south to Patna (Bihar) and Lucknow (U.P.). The subspecies *L.m. atricipala* is found from eastern Nepal eastward to Assam, Manipur and Bangladesh and south to northern Bihar and northern Orissa. The subspecies *L.m. malacca* is found in Raipur, Pachmarhi (Madhya Pradesh) and Mumbai, south to Kanyakumari. This indicates that it prefers good rainfall areas and thus is not recorded by Ali and Ripley (1983) from the drier parts of northern and northwestern India. The distribution of this subspecies in Ali and Ripley (1983) is based on several old records and it will be worthwhile to compile recent sighting and breeding records to ascertain whether this sighting at Bharatpur was a stray record or there is a shift in the distribution of this subspecies. It may be noted that in the last three decades, northern and northwestern India has seen the emergence of large scale irrigation activity, having a major impact on the ecology of these dry areas.

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16. THE BROWN ROOFED TURTLE *KACHUGA SMITHII PALLIDIPES* MOLL, IN THE BRAHMAPUTRA DRAINAGE

The brown roofed turtle *Kachuga smithii* (Gray 1863) has two subspecies distinguished by the colouration of headshell, limbs and penis. The nominate subspecies has a plastral pattern of large dark brown to black blotches on each scute, narrowly bordered with yellow; the head, limbs, feet and penis are darkly pigmented (Das 1995); The subspecies *pallidipes* lacks the plastral pattern of dark blotches and has reduced pigmentation on head, limbs, feet and penis.

During August 1997, a live *Kachuga smithii pallidipes* was caught in a net in the Brahmaputra river near Kukurmara, 26° 03' N, 91° 25' E, Kamrup dist., Assam. It was an adult male weighing 105 gm with 9.4 cm CCL, 8.8 cm CCW, 8.4 cm SCL, 6.5 cm SCW and 7.8 cm PL. The carapace was olive with a faint yellowish rim at the periphery. The dorsal keel was slightly brown up to vertebral 3. The plastron was pale yellow and prominent dark blotches were present on the ventral side of the marginals forming a broad rim at the periphery. Other characteristics were similar to the description of Moll (1987). The specimen lacked a spine as shown by the nominate subspecies of this region (Choudhury 1996).

The subspecies *pallidipes* has been reported from Bherihari Wildlife Sanctuary

(Bihar), Ghagra river at Girija Barrage (Uttar Pradesh), Kapurthala (Punjab), Kaziranga National Park (Assam) and from Nepal and Bangladesh (Moll 1987, Das 1995). However, Bhupathy *et al* (1992) and Choudhury (1996) reported the presence of only the nominate subspecies in Assam. The present record confirms the presence of *Kachuga smithii pallidipes* in Assam, and is the first report of it occurrence from lower Assam.

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17. *PYXIDEA MOUHOTII* (GRAY) IN SOUTHERN ASSAM AND MIZORAM

The keeled box turtle *Pyxidea mouhotii* (Gray 1862) has been recorded from only a few localities in northeast India, mostly from the south bank of the Brahmaputra river. The recorded localities were North Cachar Hills and Karbi Anglong, Assam (Choudhury 1993), Khasi and Garo Hills, Meghalaya, Namdapha National Park, Mehao Sanctuary (Bhupathy and Choudhury 1992) and Drupong Reserve Forest (Choudhury 1996a) Arunachal Pradesh, and in Tamenglong dist., Manipur (Choudhury 1996b). The record from Drupong is the only one from the north bank of the Brahmaputra river. Extralimitally, the species has been recorded in Indochina from Myanmar to Vietnam and also Hainan (Stubbs 1991).

On October 13, 1997, I obtained a carapace of the species from a hut near Katlichara in Hailakandi dist., southern Assam. A villager had collected it from Khajuara inside the Innerline Reserve Forest (24° 25' N, 92° 40' E 200 m. above msl) where the Reang tribals consume it whenever it is found. The Innerline Reserve Forest is mostly tropical wet evergreen rainforest, with small patches of marshes in low hills. This is the first record of the species from the entire southern Assam region (also known as the Barak Valley). Khajuara is located near the Assam-Mizoram interstate boundary and the terrain and habitat is similar on both sides of the border, thus suggesting its presence in the latter state also. This is the southernmost record for the species in India, the earlier being in Manipur at 24° 40' N (Choudhury 1996b).

The carapace (AUC 49) measured (in cm): straight line carapace length 17.5; curved carapace length 19.3; Straight line carapace width 12.8; curved carapace width 18.5 and carapace height 6.3.

I would like to thank Romu Mazumdar, Nozrul and Abdur Rahim for obtaining the carapace.

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18. BREEDING BIOLOGY OF COMMON HOUSE LIZARD *HEMIDACTYLUS FLAVIVIRIDIS* RÜPELL IN MIZORAM, INDIA

Many species of gecko are commensal of man and seen on the walls inside buildings (Daniel 1983). In Mizoram, the common house lizard *Hemidactylus flaviviridis* Rüpell is found throughout the year, even during the winter in concrete houses, as the temperature in December and January does not drop significantly (Harit 1996). These lizards usually lay two (rarely one or three), eggs in a clutch, between April and May. Eggs are laid in crevices or in a secluded dark corner (Daniel 1983, McCann 1940).

These observations were made at Kolasib, Mizoram, which lies on a hilly terrain located midway between Aizawl and Silchar (Assam), in a window on the second storey of a house. A hole *c.* 5 cm deep, is visible from inside when the window is open. This window faces direct sunlight from the afternoon to the late evening. In 1995 and 1996, I saw two eggs laid inside the hole.

On June 23, 1997, at 0500 h when I opened the window before sunrise, I saw a lizard inside the hole. It was collected and kept in a glass jar covered with fine cloth. It laid two eggs on June 25, 1997. Later the lizard was released. One egg hatched on September 1, 1997; the second egg did not hatch. The hatching took place 68 days after laying. The juvenile was provided with fruit flies inside the jar, but refused to feed and died on October 5, 1997, 35 days after hatching.

The incubation period has been previously reported as 54 days (McCann 1940) and 33 - 54 days (Daniel 1983).

Copulating pairs have been observed from February to November, while Sanyal and Prasad (1967) stated that mating occurs in March and April, generally during the morning and evening till 2200 h. The copulation at this locality was completed in 8 - 10 minutes, which confirms the observation of McCann (1940).

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19. REDISCOVERY OF *CALOTES ANDAMANENSIS* BOULENGER 1891 AND A REASSESSMENT OF THE TYPE LOCALITY

Calotes andamanensis Boulenger 1891 was based on a single specimen labelled "Andaman Islands" (in the Bay of Bengal, India), without further data on collector or date of collection, that is currently in the collection of Zoologisk Museum, Kobenhavns Universitet, Copenhagen, Denmark (ZMUC R36944). The species, which has been listed as valid in subsequent reviews (Moody, 1980; Smith, 1935; Wermuth, 1967), has never been collected from this locality, nor reported since the original description.

On April 11, 1997 and June 21, two female *Calotes* were found nesting on the forest floor at Kakachi, Kalakad Tiger Reserve (8° 25'-8° 53' N and 77° 10'-77° 35' E), Tirunelveli dist., Tamil Nadu State, southwestern India. Both produced four eggs that were elliptical in shape, of mean dimensions 16 x 9 mm and mean weight 0.8 gm. One lizard has been deposited in the museum of the Bombay Natural History Society, BNHS Regn. No. 1436.

We allocate the two agamids to *Calotes andamanensis* Boulenger, 1891, for showing the following features: SVL 76.0 and 79.0 mm; TBL 223 and 206 mm; body weight 7 and 10 gm; supralabials 10 and 10; infralabials 10 and 10; two postmentals; midbody scale rows 67 and 68; rostral bounded posteriorly by three scales; nares bounded by six small scales; tympanum small, three scales wide; finger III and IV subequal; toe IV > III; dorsal crest weakly developed on the nuchal and midbody regions; nuchals enlarged; midbody and ventral scales bear a single keel; lamellae under toe IV 32. The body is slender and compressed, the tail long, feebly swollen at the base. In addition, the body is light green dorsally, the supralabial region bluish, and there is an orange stripe between the supralabial and the orbital region. The orange stripe is also present on the thighs and a few black spots on the trailing edges.

We suggest that the type locality was erroneous, as the species has not been collected from the Andaman Islands since the original description, despite numerous surveys. Further, the high endemicity of the herpetofaunas of the Andamans (which is an impoverished subset of the Burmese, rather than the Indian fauna) and particularly of the Western Ghats and finally, all members of the section of *Calotes* to which *C. andamanensis* was assigned in the identification key in Smith (1935) are from Sri Lanka and peninsular India. The sole exception is the then poorly-known southeast Asian *C. kingdonwardi* Smith 1935, which, at the time of description, was known from the unique holotype, a juvenile male, which was tentatively included in this section. Further examples of this species have since been reported by Yang *et al.* (1979) and Zhao and Yang (1997), including *Calotes kingdonwardi bapoensis* Yang and Su in Yang *et al.* (1979). Zhao and Adler (1993) listed this taxon under *C. kingdonwardi*, but did not comment on its systematic status or affinities. In the absense of a phylogenetic hypothesis, we refrain from commenting on the affinities of *C. kingdonwardi.*

Nonetheless, in the context of Smith (1935), the group to which *C. andamanensis* was referred in the key appears to comprise a lineage within *Calotes* of slender, weak crested or crestless species that show body scales that are oriented postero-ventrally, lack axillary folds, and are only weakly sexually dimorphic in both body size and colouration.

We therefore emend the distribution of *Calotes andamanensis* Boulenger 1891 to mainland southwestern India. No males of the species are known at present, and it is suggested that these arboreal lizards descend to the ground only for nesting, which may explain why further specimens of the species have not been collected for over a century since its original description.

These findings are part of an ongoing research project to examine the impact of rainforest fragmentation on the herpetofauna and small mammals in the Western Ghats, funded by the United States Fish and Wildlife Service and the Wildlife Institute of India. We thank the Tamil Nadu Forest Department for permission to conduct field work, T.R. Shankar Raman for bringing these lizards to our attention and Aaron M. Bauer for comments on the manuscript.

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20. SEXUAL DIMORPHISM IN A MARINE PERCH *POMADASYS MACULATUS* (BLOCH)

Sexual dimorphism is an important aspect of taxonomy and fisheries. This study deals with sexual dimorphism in *Pomadasys maculatus* (Bloch), a marine perch. Thobias (1974) worked out the sexual dimorphism in the filament barb *Puntius filamentosus* (Val.); Inasu (1993) that of a freshwater puffer fish *Tetraodon travancoricus* Hora and Nair; and Tessy and Inasu (1997) elucidated the sexual dimorphism of edible perch *Priacanthus hamrur* (Cuv. & Val.).

Day (1958) described the genus *Pristipoma* with nine species. Later the genus *Pristipoma* was renamed *Pomadasys* and four species of *Pomadasys* were described by W. Fischer (1974, F.A.O). Sexual dimorphism has not been studied in any of these species.

We collected about one hundred specimens of adult *Pomadasys maculatus* (Bloch) from January to December 1997 from Munampam, Trichur dist., Kerala. Total length, head length, caudal peduncle length, maximum width, interorbital space, diameter of the eye, and internostril distance of 60 specimens were recorded separately. The specimens were preserved in 7% formaline.

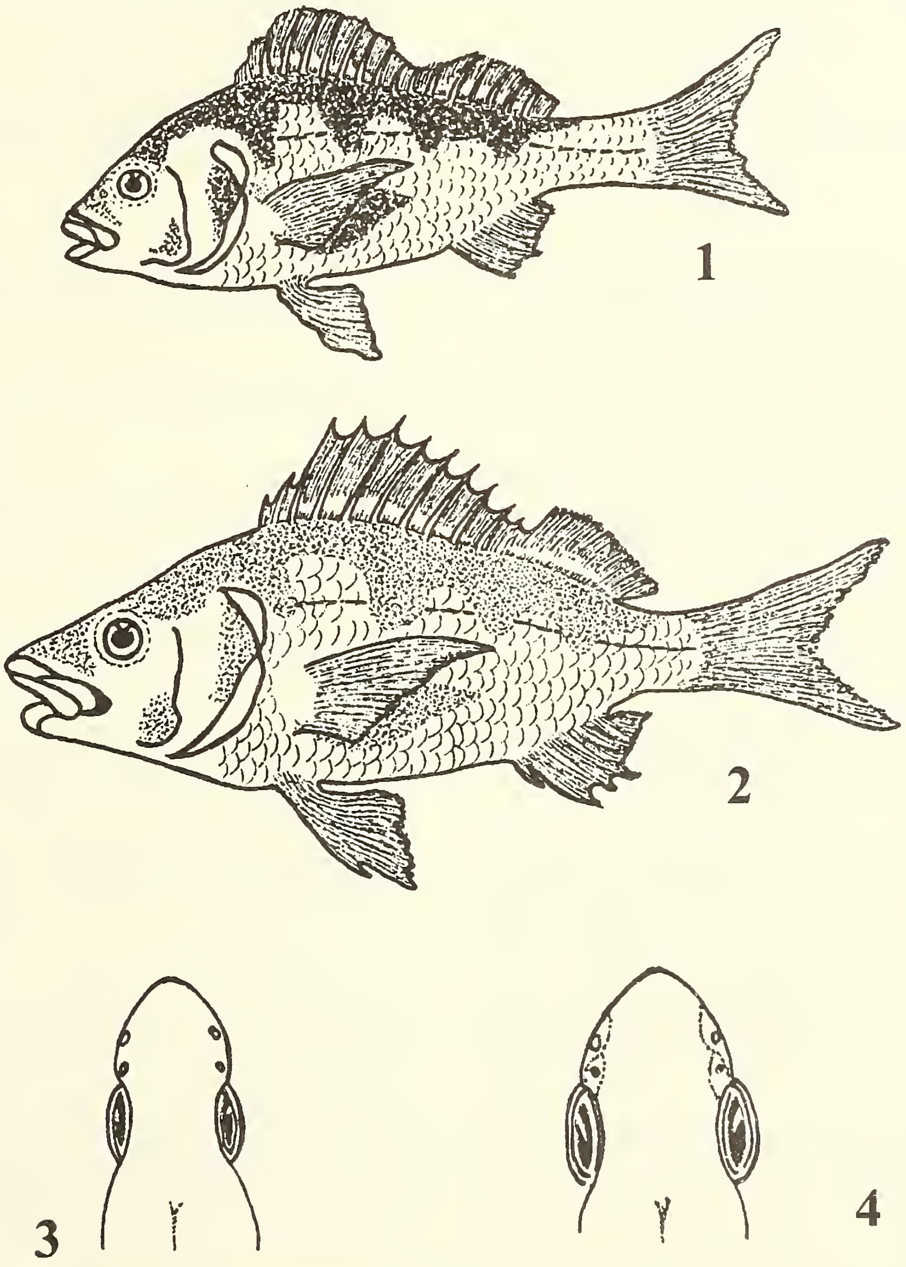
Later, the body cavity of each specimen was cut open and the gonads were examined. 28 male specimens and 32 female specimens were sorted into two groups. Morphological differences between the sexes were studied and compared by selecting two fishes of identical size of the two sexes, with the assumption that they belonged to the same age group. They were caught from the same population. Diagrams indicating the sexual dimorphism in *Pomadasys maculatus* are provided (Figs. 1-4).

Clear sexual dimorphism is exhibited by *Pomadasys maculatus*. Females are larger than males of the same age group. The anterior dorsal part of the upper jaw in the female is broader than that in the male (Figs. 1 & 2). The width of the anterior rim of the opercle in female is broader than that in the male (Figs. 1 & 2). The inter-orbital space and eye diameter of the female is larger than the male (Figs. 3 & 4). The internostril gap in males is smaller than in females (Figs. 3 & 4). Dorsal fin in females is

TABLE I-A

SEXUAL DIMORPHISM - *POMADASYS MACULATUS*
COMPARISON OF MORPHOLOGICAL FEATURES IN MALES AND FEMALES

Males		Females	
Ave. total length	15.56	Ave. total length	16.93
Ave. Head length	4.14	Ave. head length	4.77
Caudal Peduncle length	4.75	Caudal Peduncle length	5.17
Ave. inter-orbital space	1.14	Ave. inter-orbital space	1.46
Ave. eye diameter	1.01	Ave. eye diameter	1.303
Ave. internostril gap	1	Ave. internostril gap	1.03



Figs. 1-4: *Pomadasys maculatus* (Bloch)
1. Male; 2. Female; 3. Dorsal view of head, male; 4. Dorsal view of head, female

TABLE 1

COMPARATIVE STUDY ON MORPHOLOGICAL MEASUREMENTS OF *POMADASYS MACULUATUS*

Pomadasys maculatus - male								*Pomadasys maculatus* - female							
Sl. No.	Total length	Head length	Caudal length	Width	Inter-orbital	Eye	Inter-nostril	Sl. No.	Total length	Head length	Caudal length	Width	Inter-orbital	Eye	Inter-nostril
1	15.8	4.0	4.4	4.5	1.1	1	1	1	15.5	4.4	4.8	5.0	1.5	2.0	1
2	15.5	3.8	4.2	4.2	1.1	1	0.9	2	14.6	4.1	4.3	4.7	1.4	1.2	1
3	17.2	4.7	5.4	5.0	1.1	1	1	3	15.4	4.4	4.9	5.0	1.5	1.3	1
4	16.6	4.8	5.1	5.2	1.1	1.1	1	4	16.0	4.9	5.1	5.2	1.5	1.3	1
5	15.8	4.3	4.8	4.9	1.1	0.9	1	5	13.5	3.9	4.2	4.5	1.4	1.2	1
6	14.8	4.2	4.7	4.8	1.2	1	1	6	13.0	3.8	4.0	4.4	1.4	3.3	1
7	14.6	4.2	4.8	4.9	1.1	1.1	1	7	17.0	5.0	5.2	5.4	1.4	1.3	1
8	15.0	4.3	4.8	5.0	1.1	1.1	1	8	14.0	4.0	4.2	4.2	1.4	1.2	1.1
9	13.8	3.4	4.1	4.3	1.0	0.9	1	9	14.5	4.1	4.4	4.7	1.4	1.3	1
10	12.7	3.6	4.4	4.5	1.1	1	1	10	15.8	4.5	4.9	4.5	1.4	1.3	1
11	12.9	3.8	4.2	4.3	1.1	1.1	1	11	16.3	4.7	5.0	5.1	1.5	1.3	1
12	12.5	3.5	4.2	4.3	1.1	1	1	12	14.0	4.0	4.3	4.7	1.3	1.2	1
13	12.4	3.3	3.6	3.8	1.1	1	0.9	13	15.2	4.5	4.8	5.0	1.4	1.2	1
14	10.4	3.0	3.4	3.8	1.0	0.9	1.0	14	18.5	5.2	5.7	6.0	1.5	1.4	1.1
15	13.0	3.4	3.5	3.7	1.1	1	0.9	15	17.4	5.1	5.6	5.8	1.5	1.3	1.1
16	16.5	4.4	5.8	5.5	1.4	0.9	1	16	17.0	5.0	5.4	5.5	1.5	1.3	1
17	13.3	3.6	3.7	3.8	1.1	1.0	1.0	17	19.0	5.0	5.7	6.2	1.4	1.3	1
18	15.2	3.7	4.1	4.1	1.1	1	1	18	19.5	5.1	5.7	6.1	1.5	1.4	1.1
19	16.1	4.0	5.2	4.9	1.2	1.0	0.9	19	17.6	4.3	5.0	5.3	1.5	1.3	1
20	16.8	4.1	5.3	5.2	1.2	1.1	1.1	20	18.5	5.2	5.4	6.1	1.4	1.3	1.1
21	16.0	4.0	4.6	4.5	1.2	1	1	21	17.8	5.1	5.4	5.6	1.5	1.3	1
22	19.6	5.3	5.2	5.3	1.3	1	1.1	22	17.3	5.0	5.3	5.5	1.5	1.3	1
23	17.5	4.8	5.4	5.2	1.1	1	1	23	19.8	6.1	6.3	7.4	1.5	1.3	1.1
24	19.3	4.8	6.1	5.7	1.3	1	1.1	24	18.5	5.2	5.5	6.2	1.6	1.4	1.1
25	19.8	5.3	5.8	5.8	1.4	1.1	1.1	25	18.2	4.8	5.6	5.8	1.6	1.4	1
26	18.3	4.7	5.4	5.2	1.2	1.1	1	26	17.5	5.1	5.4	5.8	1.4	1.3	1
27	16.2	4.0	5.2	4.9	1.1	1	1	27	16.5	5.0	5.2	5.5	1.5	1.3	1
28	18.0	5.0	5.6	5.8	1.1	1	1	28	18.8	4.9	5.3	5.9	1.5	1.3	1.1
29								29	19.4	5.2	6.2	6.1	1.5	1.4	1.1
30								30	18.5	5.1	5.5	5.8	1.4	1.3	1
31								31	18.0	4.8	5.5	5.8	1.4	1.4	1.1
32								32	19.6	5.2	5.7	6.2	1.5	1.4	1.1
Average	15.56	4.14	4.75	4.75	1.14	1.01	1	Average	16.93	4.77	5.17	5.46	1.46	1.303	1.03

more filamentous and protruding (Figs. 1 & 2). The black basal spot on the edge of the dorsal fin in male is more prominent than that in the female (Figs. 1 & 2). The black blotches on the sides of the body are clearer in males than in females (Figs. 1 & 2). Females dominate males in all morphological measurements (Table 1). A comparison between males and females of the same size also proved the dominance of the females in morphological characters.

Sexual dimorphism in fishes mainly follows two patterns. In some fishes, the males are larger and more ornamented than the females of the same age group. The aforestated pattern of sexual dimorphism was observed in puffer fish *Tetraodon travancoricus* (Hora and Nair) by Inasu (1973) and in the filament barb, *Puntius filamentosus* by Thobias (1974). But in marine perch *Pomadasys maculatus* (Bloch) females are larger than the males of the same age group. The same pattern of sexual dimorphism was also reported by Tessy and Inasu (1977) in *Priacanthus hamrur* (Cuv & Val), which is also a marine perch.

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21. AGGRESSIVE BEHAVIOUR OF *CHANNA STRIATUS*

On a sunny afternoon of November 24, 1996, we were watching birds at pool near Mourigram railway station (West Bengal). Most of the birds were busy collecting food from the water or among weeds.

We observed a little egret (*Egretta garzetta*) some 7 m away on a heap of *Eichhornia*, catching small fish fingerlings, tadpoles, insects etc. The bird was collecting its food from the same place at a few minutes intervals. The fingerlings caught by the bird were of *Channa striatus* (3-4 cm in length). Suddenly, a large *Channa striatus*, approximately 50 cm long, jumped out of the water and hit the leg of the egret. The bird, losing its balance, fell into the water. At first we thought that this was accidental. But within a few seconds, the bird sat at the same place again and caught another fingerling. This time too, the large *Channa striatus* suddenly jumped out from the water in the same manner and forcefully hit the egret with its tail on its lower left side. The bird was injured, lost its balance and fell some 30 cm away. After a few seconds, the bird flew off to a tree 100 m away and did not come down during the time we remained there (about 40 minutes).

The large *Channa striatus* was probably the parent of the fingerlings and the event could be an example of parental care by the fish. Such attacks by fish are rare. Moreover, the speed of attack and accuracy of hits on target are remarkable. Huntingford (1976) has noted that aggressive behaviour is generally exhibited by male fish. But in this case, the female fish showed aggressive behaviour as it was probably taking care of her fingerlings.

A lot of experience or past memories and learning may have helped the fish to take this bold decision against the Egret (Manning and Dawkins 1995).

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22. FIRST RECORD OF *CLARIAS BATRACHUS* (LINN.) (SILURIFORMES: CLARIIDAE) FROM LAKE SURINSAR (JAMMU AND KASHMIR) INDIA

Clarias Scopoli is at present absent from Baluchistan, Iran, and Arabia, but is prolific in Africa, where it is represented by 33 species (Boulenger 1911). During the course of fish collection from Mansar and Surinsar lakes of Jammu Province during 1996-97, several specimens of air-breathing catfish *Clarias batrachus* (Linn.) were obtained by me from Surinsar Lake, a freshwater lake located about 34 km from Jammu city and about 8 km to the west of Mansar Lake. The Surinsar Lake is about 1.5 km long and 0.75 km wide. *Clarias batrachus* (Linn.) is thriving in the lake along with several other teleosts such as *Rasbora rasbora* (Ham.), *Puntius conchonius* (Ham.), *Tor putitora* (Ham.), *Channa orientalis* (Schneider), etc.

As there is no previous record of the occurrence of *Clarias batrachus* from the freshwaters of Jammu Province of Jammu and Kashmir State (Nath 1989), the present report is a new record. It is noteworthy that *Clarias batrachus* (Linn.) has not so far been recorded from Kashmir Valley either, although partially-digested specimens of the species have been recovered by me from the gut contents of some ichthyophagous birds of Kashmir Valley.

Because of a ban on fishing in Surinsar and Mansar Lakes imposed by the Govt. of Jammu and Kashmir, *Clarias batrachus* (Linn.). is thriving very well in Lake Surinsar and specimens measuring 20-25 cm are abundantly found in the littoral region of the lake.

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23. *GLYPTOTHORAX LONAH* (SYKES) — AN ADDITION TO THE ICHTHYOFAUNA OF KERALA

Catfishes of the genus *Glyptothorax* Blyth inhabit foothill rivers and swift mountain streams. These benthic fishes attach themselves to the riverbed substrate by means of a thoracic sucking disc, an adaptive structure. The range of distribution of *Glyptothorax lonah* (Sykes) is Deccan plateau, Godavari and Krishna river systems (Talwar and Jhingran 1991). Silas (1951b) extended its distribution to the head waters of Cauvery river, Coorg.

TABLE 1

SPECIES OF GENUS *GLYPTOTHORAX* BLYTH REPORTED FROM KERALA STATE

Species	Locality	Authors
Glyptothorax madraspatanum (Day)	Travancore	Hora & Law (1941), Silas (1952)
	Anaimalai and Nelliampathi hill ranges	Silas (1951a)
	Bhavani river	Rajan (1955)
	Nilgiri Biosphere Reserve, Kerala part	Easa & Shaji (1997)
Glyptothorax anamalaiensis Silas	Nilgiri Biosphere Reserve, Kerala part	Easa & Shaji (1997)
Glyptothorax annandalei Hora	Silent Valley	Remadevi & Indira (1986)
	Nilgiri Biosphere Reserve, Kerala part	Easa & Shaji 1997
Glyptothorax lonah (Sykes)	Karappara river, Nelliampathi area	New record

There is no record of the occurrence of this catfish in Kerala State to date. Thus the present report of this species is a new record for Kerala. Specimens were collected upstream of the Karappara river, main tributary of Chalakudy river, neighbouring Karapara estate, Nelliampathi, which lies at an altitude of 960 m above msl, during March 1997. Nelliampathi hills are situated at the southern margin of the Palghat Gap. The west flowing Chalakudy river, lies south of the Palghat Gap. This report becomes interesting as this species was previously recorded only from the northern side of Palghat Gap upto Cauvery river system, Coorg dist., Karnataka (Silas 1951b).

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24. FIRST REPORT OF *BARILIUS BENDELISIS* (HAM.-BUCH.) FROM A WEST FLOWING RIVER CHALAKUDY IN KERALA

Barilius bendelisis (Ham.-Buch.) is one of the principal hillstream fishes in the rivers of Jammu. It is characterised by eight to twelve dark bands descending towards the lateral line which become indistinct as spots in the adult, and lateral line scales with two black spots at their base. It was reported throughout India except Kerala (Talwar and Jhingran 1991). It was reported from Periyar lake, Thekkady by Chacko (1948), but later Jayaram (1981) and Talwar and Jhingran (1991) deemed the reports as erroneous. Rajan (1955) reported it from the Bhavani river, South India, but the collection site was not mentioned. Bhavani river (a tributary of Cauvery) is one of the main east flowing rivers in Kerala.

Easa and Shaji (1995) have reported this species from the Pambar river, Chinnar Wildlife Sanctuary, Kerala. This report confirmed the occurrence of this species in Kerala and was also its first report in Kerala. Hitherto, this species was reported only from Bhavani and Pambar rivers, in Kerala. Both these rivers are east flowing. So far this species has not been reported from the west flowing rivers in Kerala.

We record here this species from Tekkadiar, tributary of Chalakudy river, at 540 m above msl in Parambikulam Wildlife Sanctuary. Chalakudy river is a west flowing river originating from the Anaimalai hill ranges. This species occurs in smaller numbers, compared to the related common species *Barilius gatensis* (Val.) in that locality. The temperature of the water was 24.8°C and the dissolved oxygen value was 8.2 ppm.

In Kerala, *Barilius bendelisis* (Ham.-Buch.) has not been reported from west flowing rivers. Thus, the present report of the species is the first report from a west flowing river in Kerala State.

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25. NEW RECORD OF A RARE LOACH *NOEMACHEILUS MONILIS* FROM ANAIMALAI HILLS, WESTERN GHATS, TAMIL NADU

Noemacheilus monilis was originally described by Hora in 1921, based on two specimens collected from Bhavani river, Mettupalayam, Nilgiris. It has subsequently been reported only once from the same locality by Rajan (1955) who found only two specimens. Rajan (1965) also studied its ecology and food habits. The fish were found to feed on ephemeropteran and dipteran larvae, besides coleopterans and hemipterans. Jayaram *et al.* (1982) in their fish fauna of the Cauvery system listed this species only on the basis of earlier records. Menon (1987), in his revision of *Noemacheilus,* based his description of *N. monilis* on the two type specimens only. The extensive faunal collections from the Nilgiris, made by the Zoological Survey of India (ZSI) have no representatives of this species. However, Easa and Shaji (1997) reported its presence in abundance in part of the Nilgiri Biosphere Reserve in Kerala. All the reports so far have been from areas of the Nilgiris north of the Palghat Gap in the Western Ghats.

During a recent survey of the Indira Gandhi Wildlife Sanctuary by the ZSI, the third author collected this species from the Chinnar, a small rivulet flowing eastwards and draining into the Cauvery system. This is the first record of this species south of the Palghat Gap in the Anaimalai Hills.

Description: 1 ex., 39.0 mm SL, Reg. No. F. 5218, ZSI/SRS, Chinnar River, Anaimalai Hills, 7.viii.1997, Coll. M.B. Raghuanathan.

D. 3/8; P. 1/9 & 1/10; V. 8; A. 3/5; C. 19; L. 1. complete.

The morphometric details of the specimen are as follows (in mm): Total length 49.0, standard length 39.0, head length 9.8, body depth 5.6, length of snout 4.0, eye diameter 2.0, inter-orbital width 2.8, length of barbels: inner rostral 3.6, outer rostral 4.5, maxillary 3.2, predorsal distance 20.2, post-dorsal distance 19.3, distance from pectoral fin base to pelvic fin base 11.3, from pelvic fin to anal fin 10.2, from anus to anal fin 1.9, length of caudal peduncle 5.3, height of caudal peduncle 4.5, height of dorsal fin 6.4, length of pectoral fin 7.4, length of pelvic fin. 6.2, length of anal fin 5.6.

In all the biometric characters, body proportions and colour pattern, the specimen agrees with the description given by Menon (1987). The only difference observed, also mentioned by Rajan (1955), is the presence of 8 branched rays in the dorsal fin.

The present collection extends the distribution of *N. monilis* from Nilgiris in the Central Division of the Western Ghats beyond the Palghat Gap to the Anaimalais in the Southern Division. This is of zoogeographical significance as the Palghat Gap forms a dividing line between the Central and Southern Division of the Western Ghats (Bhimachar 1945). Silas (1951), in his paper on the fish fauna of Anaimalai and Nelliamapathi hills and their zoogeographical significance, suggests that the Cauvery and Ponnai watersheds which connect the Central and Southern Divisions are likely to facilitate the dispersal of fishes from north to south.

ACKNOWLEDGEMENTS

We thank Dr. A.G.K. Menon, Emeritus Scientist, the guiding force in our ichthyological studies. We also thank Dr. J.R.B. Alfred, Director and Dr. P.T. Cherian, Joint Director and Officer-in-Charge, for facilities and especially the latter for going through the manuscript.

December 15, 1997

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26. THE OCCURRENCE OF SPOT PUFFIN IN KALAKAD-MUNDANTHURAI TIGER RESERVE, SOUTHERN WESTERN GHATS

The Spot Puffin *Appias lalage* belonging to the Family Pieridae is found in Northeast Himalayas from Simla, Assam to Burma (=Myanmar) (Wynter-Blyth 1957) and is classified as rare in south India (Sathyamurthy 1966). Its occurrence has not been stated authentically in the Western Ghats. Even Wynter-Blyth (1957) and Larsen (1987 a-c, 1988) do not report it in their exhaustive survey of the Nilgiris. However, there is a lone record of this species from Neterikal in Kalakad-Mundanthurai Tiger Reserve (KMTR) of Agasthyamalai range, in the southern Western Ghats (Sathyamurthy 1966). Ferguson (1891) collected *Hyposcritia lalage* from the Eastern slopes of the Travancore hills. *H. lalage* is a synonym of *Appias lalage* (Talbot 1939). There has been no sighting or collection of this species in recent times.

During a survey conducted from 1990-1996 in the wet evergreen forest, *A. lalage* was encountered frequently. A few vagrants were also seen in the deciduous forests. Besides, it is a common mud-puddler along with 2 sympatric species *A. indra,* and *A. albina* after the monsoon at every corner of the road cutting through the forest. *A. lalage* was more abundant than the other two species. The females had more extensive black markings than males and were encountered only inside the forest. These were seasonal, emerging in great abundance only during the wet-dry transition period. During 1991 and 1996, there was an explosion in numbers and they were seen mud-puddling in unusual places like vertical rock faces and wherever there was water trickling down.

This species has a disjunct distribution, being restricted to the southern Western Ghats, south of the Palghat Gap and then occurring in the Northeast Himalayas. Scanty records of this species in Western Ghats, South India, are largely due to the lack of adequate survey work. After Ferguson's collection, which was mostly confined to the western slopes, more than a century ago, no detailed study was made in this area. The species appears to be found only in the southern Western Ghats. Intensive field survey over small spatial scale all over the Western Ghats is essential to evaluate the distributional range and present status.

ACKNOWLEDGEMENT

I thank Dr. R.K. Varshney, Zoological Survey of India, Calcutta for confirming the identification of the butterfly.

June 13, 1998

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27. *FICUS HISPIDA* (L.F.): A NEW FOOD PLANT OF THE COMMON MIME *CHILASA CLYTIA DISSIMILIS* AND *CHILASA CLYTIA CLYTIA*

The larva of the Common Mime is known to feed on laurels and cinnamon, *Alseodaphne semecarpifolia, Cinnamomum zeylanicum, Litsea deccanensis, L. sebifera* and *L. chinensis.*

On August 14, 1997, while conducting a nature trail at Tungareshwar, Thane dist., Maharashtra, I came across four caterpillars feeding on a plant which I could not identify at first. The caterpillars were collected and reared on the same plant. All the four caterpillars pupated successfully on August 23, and emerged as adults of the Common Mime *Chilasa clytia dissimilis* on September 8, 1997.

Subsequently in November 1997, I collected two caterpillars of the Common Mime on the same plant at Yewoor, Thane dist. Both these caterpillars pupated successfully and emerged as *Chilasa clytia clytia,* which could be identified by their distinct markings.

The food plant was later identified as *Ficus* *hispida.* Wynter-Blyth (BUTTERFLIES OF THE INDIAN REGION 1957) does not mention this as the food plant of the Common Mime.

The occurrence and successful rearing of both the subspecies of the Common Mime on *Ficus hispida* confirms it as a new food plant.

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28. FRESHWATER ROTIFERA: EUROTATORIA FROM ASSAM, NORTHEAST INDIA

(*With eleven text-figures*)

Rotifers have been documented from all conceivable aquatic micro- and macro-environments in all parts of the world, but these organisms are, so far, poorly recorded from subterranean waters (Pejler 1955). This also holds true for the Indian Rotifera (Sharma 1991). Taxonomic studies on the rotifers of this country were initiated more than a century ago. However, till now only two reports by Naidu (1967) and Sharma (1993) refer to their distribution in domestic water wells of Andhra Pradesh and West Bengal respectively.

The present study deals with the species composition of rotifers in various domestic wells located in and around Tezpur (26° 40' N, 92° 46' E). Upper Assam. Plankton samples were collected from 34 domestic wells in April, 1990 (summer) and from 32 domestic wells during December, 1990 (early winter). The collections were obtained by vertically towing a nylobolt plankton net (No. 25). The material so obtained was preserved in 5% formalin. Various species were isolated and identified (list below) following Koste (1978) and Sharma (1987).

The sampled domestic wells were about 20-30 years old and were characterized by acidic water (pH: 5.0 - 6.5) and low specific conductivity (71.4 - 196.4 μS/cm).

ROTIFIER SPECIES EXAMINED

Phylum : Rotifera
Class : Eurotatoria
Superorder : Monogononta
Order : Ploimida

Family: Lecanidae

Lecane bulla (Gosse, 1851) (Fig. 1)
L. closterocerca (Schmarda, 1859) (Fig. 2)
L. hamata (Stokes, 1896) (Figs. 3 & 4)
L. inermis (Bryce, 1892) (Fig. 5)
L. luna (O.F. Müller, 1776) (Fig. 6)
L. pyriformis (Daday, 1905) (Fig. 7 & 8)

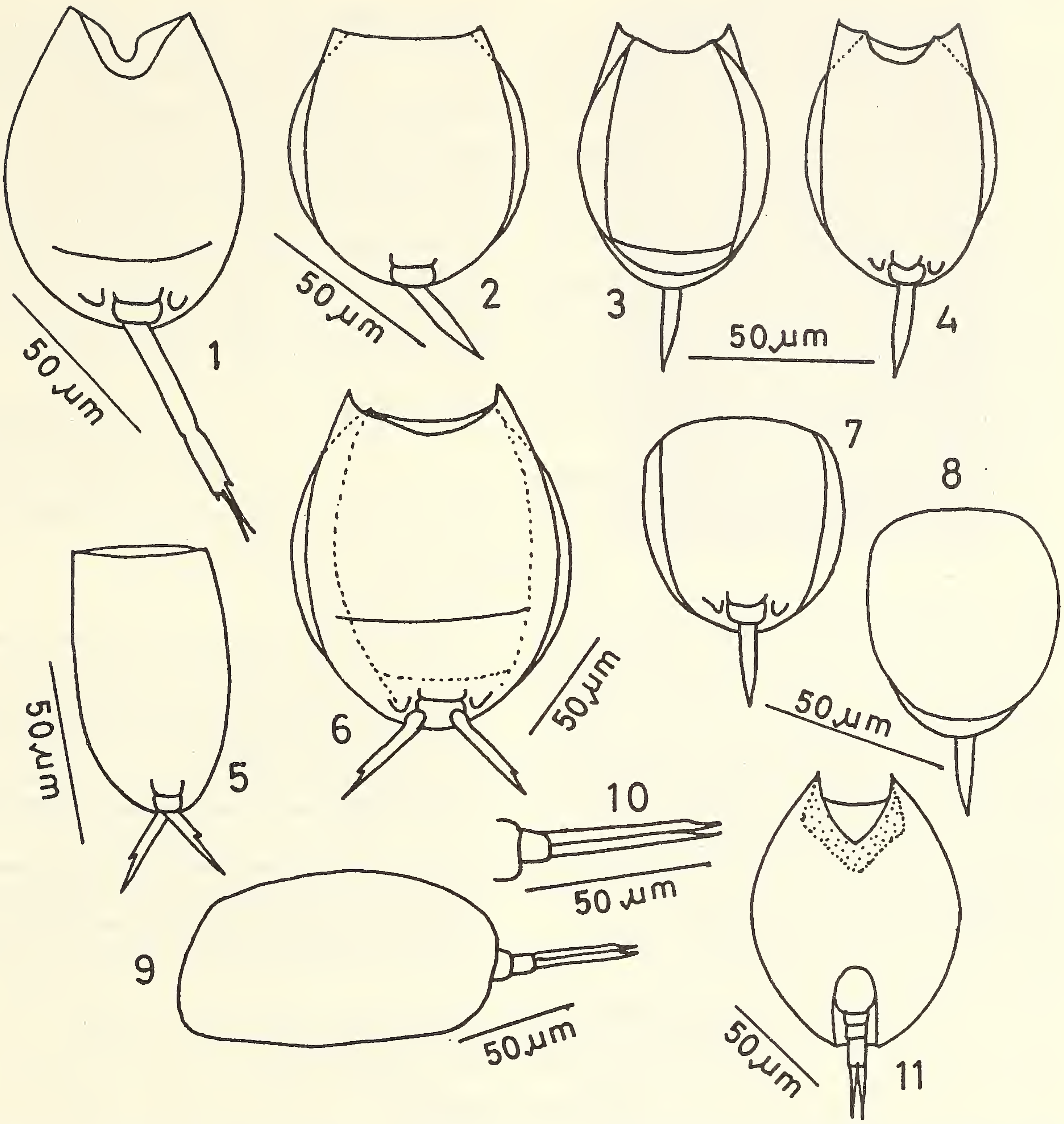
Family: Mytilinidae
Mytilina bisulcata (Lucks, 1912) (Fig. 9 & 10)

Family: Colurellidae
Lepadella patella (O.F. Müller, 1776) (Fig. 11)

Eight species of monogonont rotifers belonging to 3 genera, representing three eurotatorian families are documented. The recorded species richness compares well with the observations from West Bengal (Sharma 1993) but our study revealed comparatively lower generic diversity. Lower qualitative abundance of Rotifera in the domestic wells of Assam conforms with earlier investigations and with the results of Ronenberger (1975) and Pejler (1995). The paucity may be attributed to the pristine subterranean environs.

Three species, namely, *Lecane bulla, L. inermis* and *L. pyriformis,* represented new reports from these biotopes, bringing the known species of monogononts from domestic wells in India upto 16.

All the presently recorded species are euryecious cosmopolitan elements. Of these,



Figs. 1-11: *Lecane bulla* (Gosse): 1. ventral view; *L. closterocerca* (Schmarda): 2. ventral view; *L. hamata* (Stokes): 3. dorsal and 4. ventral view; *L. inermis* (Bryce): 5. ventral view; *L. luna* (Müller): 6. ventral view; *L. pyriformis* (Daday): 7. ventral and 8. dorsal views; *Mytilina bisulcata* (Lucks): 9. lateral view, 10. toes (enlarged); *Lapadella patella* (Müller): 11. ventral view.

Mytilina bisulcata and *Lecane inermis* are of ecological interest. The former is an acidophilic species (Sharma 1991), while *L. inermis* appears to be confined to acidic waters in Meghalaya (Sharma 1987) and the present study also affirms its acidophilic nature. Further, both *M. bisulcata* and *L. inermis* are of regional distributional importance in India. The examined taxocoenosis is characterized by qualitative dominance of *Lecane* sp. The same has been observed in domestic wells in West Bengal (Sharma 1993) but the samples from Assam contained more species of the family Lecanidae.

The observed species composition differed notably from earlier studies from Andhra Pradesh (Naidu 1967) and West Bengal (Sharma 1993). The rotifer communities from Assam registered 16.2% and 47.1% similarities [vide Sorensen Index (Sorensen 1948)] with those from the Andhra Pradesh and West Bengal. *Lapadella patella* is the sole species common to the samples from Assam and Andhra Pradesh. On the other hand, four species i.e., *Lecane closterocerca, L. luna, Lepadella patella* and *Mytilina bisulcata* were found to be common to Assam and West Bengal.

The rotifers were observed in 18 (about 53%) of the total 34 domestic wells sampled during summer (April 1990). They, however, occurred in only five (16%) out of the total 32 domestic wells sampled during early winter (December 1990). The percentage occurrence is relatively lower than the results from West Bengal (Sharma 1993), which indicated rotifers in 16 (64%) out of total 25 sampled domestic wells. Further, *Lecane closterocerca* and *L. hamata* depicted co-occurrence in a number of collections from Assam, while other species appeared to be rare in the present study.

May 11, 1998

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29. RECORD OF *HOMALOCANTHA SECUNDA* (LAMARCK 1822) FROM OKHA IN GULF OF KUTCH

(*With one text-figure*)

Family Muricidae (Mollusca) is well represented along the Indian coast. However, most publications are based on surveys made in the early 1950s. Rao and Rao (1993) report 60 species of *Murex* from the Andaman and Nicobar Islands, from collections of the Zoological Survey of India.

The literature on molluscs along the west coast of India is sparse. Notable contributions are those of Melvill and Abercrombie (1893), Subrahmanyam *et al.* (1952), and Menon *et al.* (1961). Among the publications from south and southeast coast of India, those of Crichton (1941), Gravely (1942), Satyamurthi (1952), and Rao and Rao (1993) are important.

During a survey conducted in 1995 at Okha, I came across a mating pair of small *Murex* which could not be identified immediately. The specimens have a shouldered whorl, frilled outer lip, long siphonal canal which is open, with three to four short, strong spines. The larger shell is

40 mm. The specimens are of *Homalocantha secunda* (Lam.) (Fig. 1), which has been described by Rao and Rao (1993).

H. secunda is found along the coast of south India at Chennai (= Madras) (Gravely 1942) and the southern tip of India (D'Attilio 1983). The extralimital distribution of the species is reported as Sri Lanka, northwestern Australia to Indonesia and New Caledonia (Redwin and D'Attilio 1976). None of the available publications mention its occurrence on the west coast of India. The presence of live specimens at Okha in the Gulf of Kutch confirms its distribution on the west coast of India.

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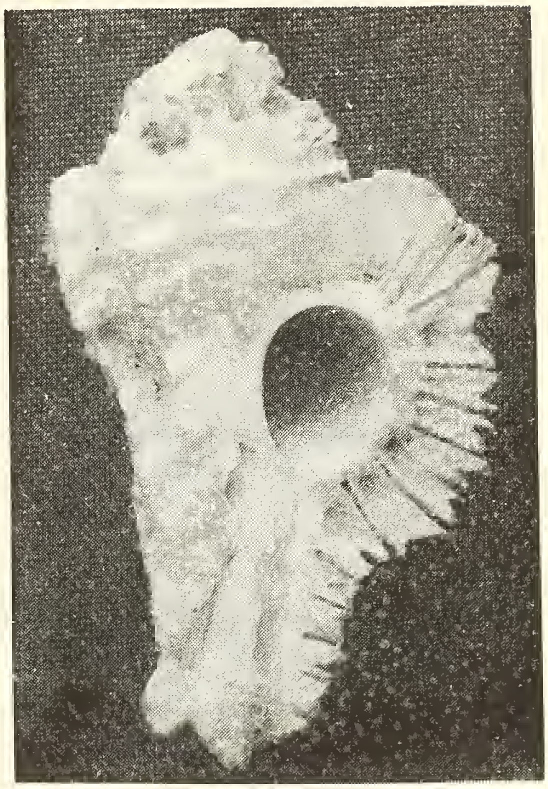

Fig. 1: *Homalocantha secunda* (Lamarck 1822)

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30. THREE NEW RECORDS OF CLADOCERA (CRUSTACEA) FROM INDIA

(*With eighteen text-figures*)

Cladocerans are well known in India. Recently Michael and Sharma (1988) published a FAUNA OF INDIA volume on Cladocera covering 90 species. The present study reports the occurrence of three species viz. *Alona cannellata* Brehm, 1934, *A. pseudanodonta anodonta* Daday, 1905 and *A. holdeni* Green, 1952. The first two were collected from Madurai, Tamil Nadu 9° 53' N lat., 78° 8' E long. and the third from Keoladeo National Park, Bharatpur, Rajasthan 27°10' N lat., 77° 31' E long. The three species are reported for the first time from the

Oriental region. They were earlier recorded from localities in Africa.

Family CHYDORIDAE
Subfamily Aloninae
Genus *Alona*

1. ***Alona cannellata*** Brehm 1934 (Figs. 1-6)

Female: Body length 0.41 mm; body width 0.26 mm. Postero-dorsal and postero-ventral corner of valves rounded. Valves with longitudinal lines, 10-13 lines at the posterior margin (Fig. 1). Rostrum blunt (Fig. 2). Antennules reaching apex of rostrum, about half as wide as the eye. Posterior margin of the valve with undulation (Fig. 3). Anterior margin of ventral side of valve with small spines (Fig. 4). Plate of labrum rounded with a step-like incision on the anterior margin (Fig. 5). Postabdomen with distinct preanal and postanal corner. Dorsal distal corner projecting and rounded. Six to eight anal denticles, anal margin with groups of setae, lateral groups of setae indistinct (Fig. 6). Claw with a basal spine half as long as the claw, with a seta at the base.

Remarks: *A. cannellata* occurs at Kallanthri pond, Madurai, Tamil Nadu. This species was first described by Brehm (1934) from Niger basin, Africa. Smirnov (1971) has given an account of this species in his FAUNA OF THE WORLD: CHYDORIDAE. The present specimens agree with the description given by Brehm (1934), except for the position of ocellus and shape of postabdomen. The presence of an incision on the labrum is also a slight variation.

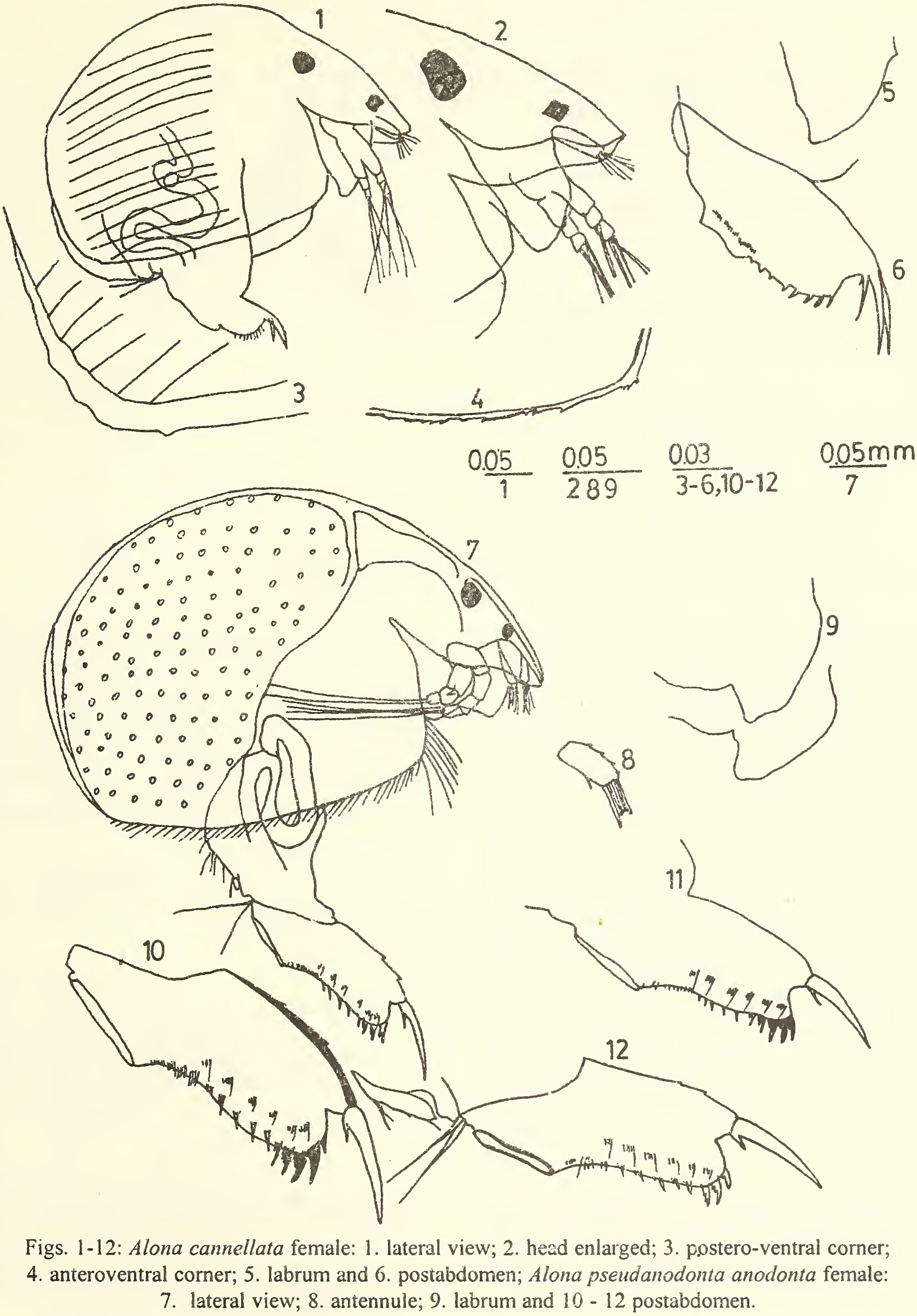
2. ***Alona pseudanodonta anodonta*** Daday 1905 (Figs. 7-12).

Female: Body length 0.41 mm, body width 0.28 mm. Valves with rows of tubercles, gramiate between rows, postero-dorsal and postero-ventral corners rounded, postero-ventral corner projecting beyond the postero-dorsal corner (Fig. 7). Maximum height in the middle. Rostrum blunt, short and not curved. Antennule somewhat slender, reaching almost the tip of the rostrum, with three to four small spines on the dorsal side (Fig. 8). Ocellus slightly smaller than eye, situated halfway between eye and apex of rostrum. Plate of labrum rounded anteriorly, undulating at the posterior half and blunt (Fig. 9). Ventral margin of valves slightly convex, with long antero-ventral setae (more than twice the length of middle setae). Postabdomen slightly widened distally with distinct preanal and postanal corners (Figs. 10-12). Anal groove concave, dorsal-distal margin evenly rounded and projecting beyond the base of claw. Dorsal margin with 8-10 denticles attached submarginally, followed by 3-4 groups of spines along the anal margin. Claw stout, rather long, slightly curved and evenly tapering distally with a short basal spine (as long as basal diameter of claw). Concave surface of claw with a series of five setules ending a short distance from the tip.

Remarks: *A. pseudanodonta anodonta* was found in a temporary pond near Kallanthri, Madurai, Tamil Nadu. This species is somewhat similar to *A. karelica* Stenroos (1897) and *A. archeri* Sars (1889), especially in the shape of postabdomen and in carapace morphology. However, it is completely different from these two species in the shape of the labral plate, carapace morphology and arrangement of setae and setules on the ventral margin of the valves and on the structure of the postabdomen.

3. ***Alona holdeni*** Green 1952 (Figs. 13-18)

Female: Body length 0.42 mm. Valves with 20-24 longitudinal lines (Fig. 13). Postero-dorsal and postero-ventral corner rounded without spines. Antennules not reaching the apex of the rostrum (Fig. 14). Antennules slender, with two small spines on the dorsal side (Fig. 15). Proximal segment of endopodite of antenna with a spine which almost reaches the distal end of the third segment (Fig. 16). Ocellus slightly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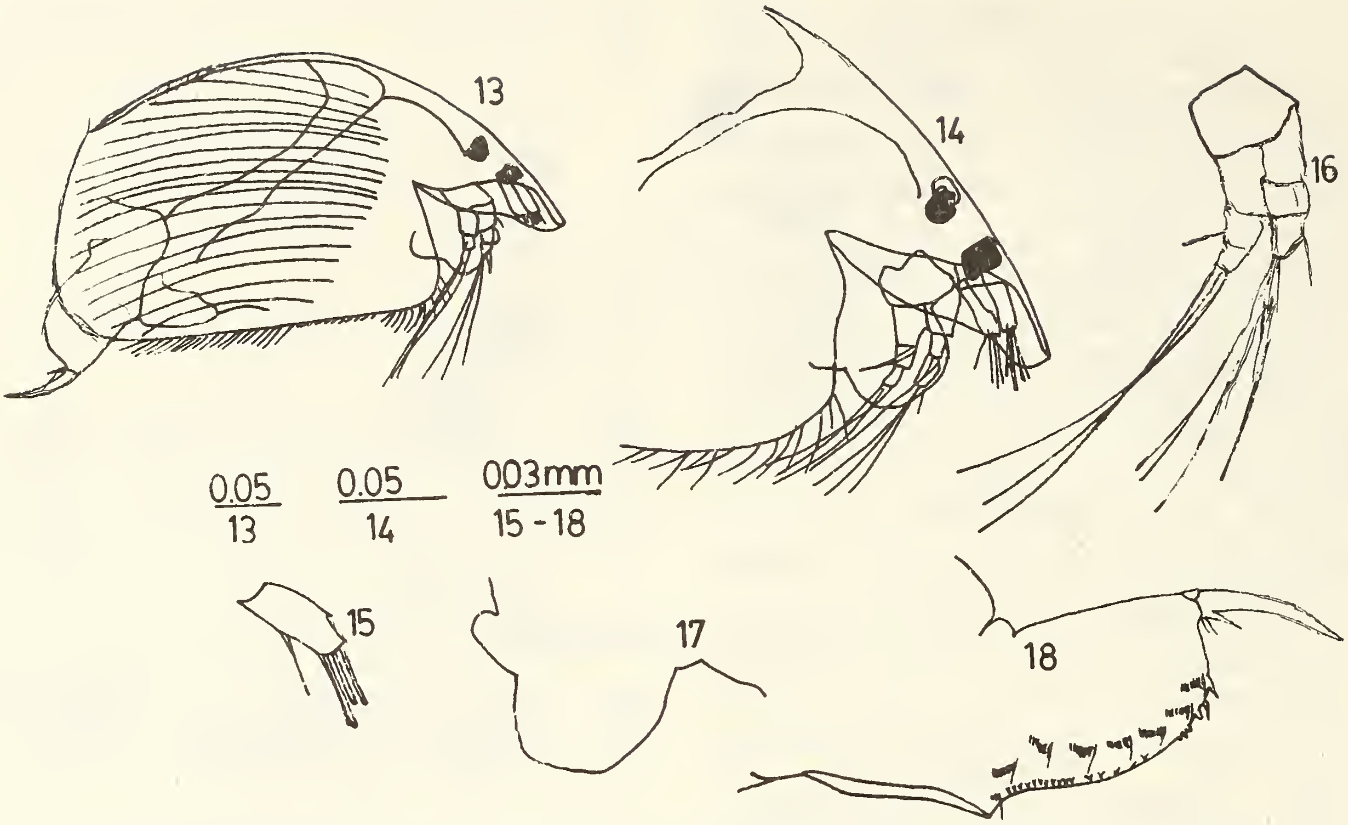
Figs. 1-12: *Alona cannellata* female: 1. lateral view; 2. head enlarged; 3. postero-ventral corner; 4. anteroventral corner; 5. labrum and 6. postabdomen; *Alona pseudanodonta anodonta* female: 7. lateral view; 8. antennule; 9. labrum and 10 - 12 postabdomen.



Figs. 13-18: *Alona holdeni* female: 13. lateral view; 14. head enlarged; 16. antennule; 15. antenna; 17. labrum and 18. postabdomen.

larger than eye, situated closer to the eye, being about 2/5 x distance between eye and tip of rostrum. Postabdomen (Fig. 18) with rounded anal margin and distinct preanal corner. About 10-12 denticles present submarginally and followed by 3-4 groups of spines along the anal groove. About seven groups of setae present laterally, the distal-most seta being the longest in each group and three distalmost groups reaching the margin of postabdomen. Claw rather long with very short basal spine, about as long as basal diameter of claw, and two long setae present together at the base of the claw.

Remarks: *A. holdeni* occurs in the marshes of Keoladeo National Park, Bharatpur, Rajasthan. This species agrees well with *A. holdeni* Green (1952) from Niger River, Africa except for the arrangement of the setules on the ventral side of the valves (Fig. 415, N.N. Smirnov, 1971) and the size of the ocellus. Green (1952) described it with a smaller ocellus than eye. The original description of *A. holdeni* is inadequate to compare with my specimens. The few specimens available to me do not enable me to present an elaborate description.

I thank the Director, Zoological Survey of India, Calcutta and the Officer-in-Charge, MBS, ZSI, Madras for facilities.

July 16, 1997

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31. ADDITIONS TO THE FLORISTIC HISTORY OF ORISSA

In spite of intensive and extensive works on the botany of Central India (Haines, 1921-1925; Mooney, 1950), our surveys from 1986-1989 in Sambalpur dist. have yielded new distributional records for Orissa and for India (Panda and Das 1989a, 1989b, 1991, 1992a, 1992b 1993, 1995; Panda *et al.* 1989, 1992a, 1992b; Panda, 1990). New distributional records of a few taxa are given here with their Exsiccatus, flowering and fruiting time, frequency, distribution, ecology and uses.

Alternanthera paronychioides St. Hil., Voy. Bres. 2: 439. 1833; Veldkamp in Blumea 19: 167. 1971 (AMARANTHACEAE).

Exsicc.: Brook's Hill, Sambalpur, 30.xi.1987, *Das et Panda 864.*

Fl. & Fr.: January-December.

Frequency: A common weed of cultivated fields and wastelands across the district.

Distribution: A native of tropical America, now naturalized in various parts of the tropics.

Ecology: The preferred soil is loam and clay, rarely on rocks. Grows in open places in association with *Mecardonia procumbens* (Miller) Small, *Lindernia anagallis* (N. Burm.) Pennell, *Sphaeranthus indicus* L., various grasses and sedges.

Use: Diuretic, used occasionally.

Note: Fairly naturalized in various parts of the dist., being a new member of the flora of Orissa, was not recorded by Haines (*l.c.*) and Mooney (*l.c.*).

Alternanthera pungens H.B.K., Nov. Gen. Sp. 2: 206. 1818; Melville in Kew Bull. 1958: 174. 1958. (AMARANTHACEAE)

Achyranthes repens L., Sp. Pl. 205. 1753.

Alternanthera repens (L.) Link, Enum. Pl. Hort. Berol. 1: 154. 1821, *non* Gmelin 1791; Backer in van Steenis, Fl. Males. 4: 91. 1949.

Exsicc.: Badrama, 25.ix.1987, *Das et Panda 786.*

Fl. & Fr.: January-December.

Frequency: Common, naturalized on wet wastelands throughout the district.

Distribution: A native of tropical America; now pantropical.

Ecology: A weed of open places in loamy and clay soil, growing in association with *Phyla nodiflora* (L.) Greene, *Mollugo pentaphylla* L., *Phyllanthus virgatus* Forst.f., *Stachytarpheta indica* (L.) Vahl, etc.

Use: The entire plant is used as a diuretic.

Note: It was not recorded by Haines (*l.c.*) and Mooney (*l.c.*).

Leucas biflora (Vahl) R. Br., Prodr. 504. 1810; Wt., Ic. t. 866. 1844-45; Hook. f. in Hook. f., Fl. Brit. India 4: 683.1885 (excl. Syn. *L. procumbens* Thw.). (LAMIACEAE)

Phlomis biflora Vahl, Symb. Bot. 3: 77. 1794.

Exsicc.: Ambanala, Badrama, 8.vii.1987, *Das et Panda 664.*

Fl. & Fr.: July-December.

Frequency: Rare, found only at Ambanala.

Distribution: Peninsular India, Sri Lanka.

Ecology: Grows often in dry places in sandy-loamy soil. Associated plants are *Amaranthus viridis* L., *Cassia pumila* Lam., *Crotalaria prostrata* Rottl., *Flemingia chappar* Benth., etc.

Note: So far endemic to Peninsular India and Sri Lanka (Hook. f., *l.c.*), now reported from Sambalpur, making a new record for Orissa and eastern India. Haines (*l.c.*) and Mooney (*l.c.*) have not recorded it.

Nesaea brevipes Koehne, in Engl. Bot. Jahrb. Syst. 3: 326. 1882 & Pfreich. Ht. 17: 226. 1903; Blatter and Hallberg in *JBNHS* 26: 216; Gamble, Fl. Pres. Madr. 1: 510 (360). 1919; Matthew, Mat. Fl. Tamilnadu Carnatic 218. 1981 & Ill. Fl. Tamilnadu Carnatic t. 281. 1982 (LYTHRACEAE)

Ammannia cordata Wt. & Arn., Prodr. 1: 304. 1834, *non Nesaea cordata* Hiern. In Oliver, Fl. trop. Afr. 2: 475. 1871. Clarke in Hook. f., Fl. Brit. India 2: 570. 1879; Prain, Beng.

Pl. 1: 501. 1903.

Exsicc.: Dhankaorah, Sambalpur, 7.xi.1986, *Das et Panda 440*; Bamra, 23.ii.1987, *Das et Panda 467*.

Fl. & Fr.: October-March.

Frequency: Common in the district.

Distribution: Southeast India, Bangladesh, Sri Lanka.

Ecology: A crop-field weed of marshy places in loamy-clayey soil. Associated plants include *Tridax procumbens* L., *Caesulia axillaris* Roxb., *Euphorbia hirta* L., *Evolvulus alsinoides* (L.).

Note: A new record for Orissa. Haines (*l.c.*) and Mooney (*l.c.*) did not record it, but Clarke (*l.c.*) noted it from Noakhali of erstwhile East Bengal, presently Bangladesh, Deccan Peninsula of India and Sri Lanka. Prain (*l.c.*) commented that it is "very rare in East Bengal" occurring as a weed of wetlands. Gamble (*op. cit.*) recorded its distribution in the Circars and Deccan. Matthew (Fl. Tamilnadu Carnatic Pt. I: 610. 1983) corroborated Clarke's records of the world distribution of the species. This report from Sambalpur (Orissa) appears to have filled the gap in its apparently disjunct distribution in south-eastern Indian subcontinent i.e. Bengal in the east and Peninsula and Sri Lanka in the south. The species is endemic to the Indian Sub-continent.

Synedrella nodiflora (L.) Gaertn., Fruct. 2: 456. t. 171, f. 7. 1791; Clarke, Comp. Ind. 139. 1876; Hook. f. in Hook. f., Fl. Brit. India 3: 308.1881; Prain, Beng. Pl. 1: 615. 1903; Gamble, Fl. Pres. Madr. 2(4): 708. 1921 (ASTERACEAE)

Verbesina nodiflora L., Cent. Pl. 1: 28. 1755 *et* Amoen. Acad. 4: 290. 1759.

Exsicc.: Pradhanpat, 23.i.1989, *Das et Panda 1328*.

Fl. & Fr.: August-January

Frequency: Less common.

Distribution: A native of tropical America; fairly naturalised in the tropics.

Ecology: Prefers cultivated ground in clay soil. Associated plants include *Glinus lotoides* L., *Hygrophila salicifolia* (Vahl) Nees, *Scoparia dulcis* L., *Bidens pilosa* L.

Uses: Leaf-extract laxative, applied locally in rheumatism. Used as fodder.

Note: Recently introduced in this area. Haines (*l.c.*) and Mooney (*l.c.*) did not record it from Orissa.

Torenia asiatica L., sp. Pl. 619. 1753; Hook. f. in Hook. f., Fl. Brit. India 4: 277. 1885, Yamazaki in Enu. Fl. Pl. Nepal 3: 127, 1982. (SCROPHULARIACEAE)

T. cordata (Griff.) Dutta in Bull. Bot. Soc. Beng. 19:25.1965.

Treisteria cordata Griff. Notul. 4:190.1854.

Exsicc.: Hatigirdha, Kholbilung, 4.xi.1986, *Das et Panda 263*.

Fl. & Fr.: May-December

Frequency: Rare, found at Kholbilung and Nrusimhanath.

Distribution: India, Sri Lanka, Myanmar, Java, Nepal, east to China, Malaysia.

Ecology: In open and dense forests from dry to moist places, in loamy-clay to rocky soil. Associated plants are *Hemigraphis hirta* (Vahl) T. Anders., *Barleria cristata* L., *Canscora diffusa* (Vahl) Roem. *et* Schult.,

Note: A widely distributed species in India from peninsula to northern hills, preferably hilly region. Indian distribution in Peninsula, West Bengal (Darjeeling, Kurseong 940 m) and Assam. This report of the species from Sambalpur is a new addition to the flora of Orissa. Haines (*l.c.*) and Mooney (*l.c.*) did not record it from Orissa. Dutta's (*l.c.*) remark "... seems to be an endemic species" appears to be erroneous as it is widely distributed.

Trichodesma indicum var. *amplexicaule* (Roth) Cooke, Fl. Bombay 2: 215. 1904; Kazmi in J. Arn. Arbor. 52:518.1971; Banerjee & Pramanik in Bull. Bot. Surv. India 17:113.1978. (BORAGINACEAE)

T. amplexicaule Roth, Nov. Pl. Sp. 104. 1821; Clarke in Hook. f., Fl. Brit. India 4:153.1883, pp.

Exsicc.: Pension Para, Sambalpur, 25.viii.1986, *Das et Panda 157*; Kapildhar, Nrusimhanath, 7.iv.1988, *Das et Panda 1120.*

Fl. & Fr.: January-December

Frequency: Common.

Distribution: India, Myanmar, Sri Lanka, Pakistan, Cabul (=Kabul), Baluchistan, Persia, Mauritius.

Ecology: In open, dry or moist places, also in the forests, in lateritic soil and in rock crevices, growing in association with *Laggera aurita* (Willd.) Sch.-Bip., *Hedyotis nitida* Wt. & Arn., *Hemigraphis latebrosa* (Roth) Nees.

Uses: Infusion of leaves and roots used in dysentery. The plant is emollient and diuretic.

Note: Lamina amplexicaule at base. A widely distributed taxon in the plains in India. Haines (*l.c.*) did not make any infraspecific category and noted "probably in all districts" of Bihar and Orissa. Banerjee and Pramanik (*op. cit.*) cited specimens from Bihar, Madhya Pradesh, Rajasthan, Gujarat, Maharashtra, Andhra Pradesh, but none from Orissa. This collection is the first addition of the taxon to the Central National Herbarium (CAL) from Orissa.

Trichodesma indicum var. *subsessilis* Clarke in Hook. f., Fl. Brit. India 4: 153. 1883; Banerjee and Pramanik, *op. cit.* 114. 1978. (BORAGINACEAE)

T. subsessilis Wall., Cat. n. 933. 1828 *Nom. nud.*

Exsicc.: Bamra, 3.xi.1986, *Das et Panda 217.*

Fl. & Fr.: January-December.

Frequency: Common across the district.

Distribution: India, Burma (Myanmar), Pegu.

Ecology: In open, dry or moist land on loamy soil, associated with *Sida cordifolia* Linn., *S. spinosa* L., *Croton bonplandianum* Baill., *Euphorbia hirta* L.

Note: Lamina base attenuated into a short petiole, never amplexicaule at base. Banerjee and Pramanik (*op. cit.*) reported its distribution in Jammu & Kashmir, Uttar Pradesh, Madhya Pradesh, Bihar and different parts of North India. This report from Sambalpur is a new record for Orissa as well as peninsular India.

Typhonium diversifolium Wall. (Numer. List: 300, n. 8933. 1849, *nom. nud.*) *ex* Schott, Aroid. : 13, t. 20. 1855; Hook.f. in Hook. f., Fl. Brit. India 6 : 510. 1893. (ARACEAE)

Heterostalis diversifolia (Wall. *ex.* Schott) Schott in Oesterr. Bot. Wochenbl. 7:261.1857.

Exsicc.: Hirakud, 24.viii.1986, *Das et Panda 06.*

Fl. & Fr.: July-December.

Frequency: Not common, but found throughout the district.

Distribution: India, Nepal, S. Tibet.

Ecology: Grows in semi-open places on moist loamy lateritic soil, in association with *Plesmonium margaritiferum* (Roxb.) Schott, *Lindenbergia indica* (L.) O. Ktze., *Solanum nigrum* L.

Note: Haines (*l.c.*) and Mooney (*l.c.*) are silent on this species in Orissa. It is endemic to the Indo-Nepal region.

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December 23, 1997

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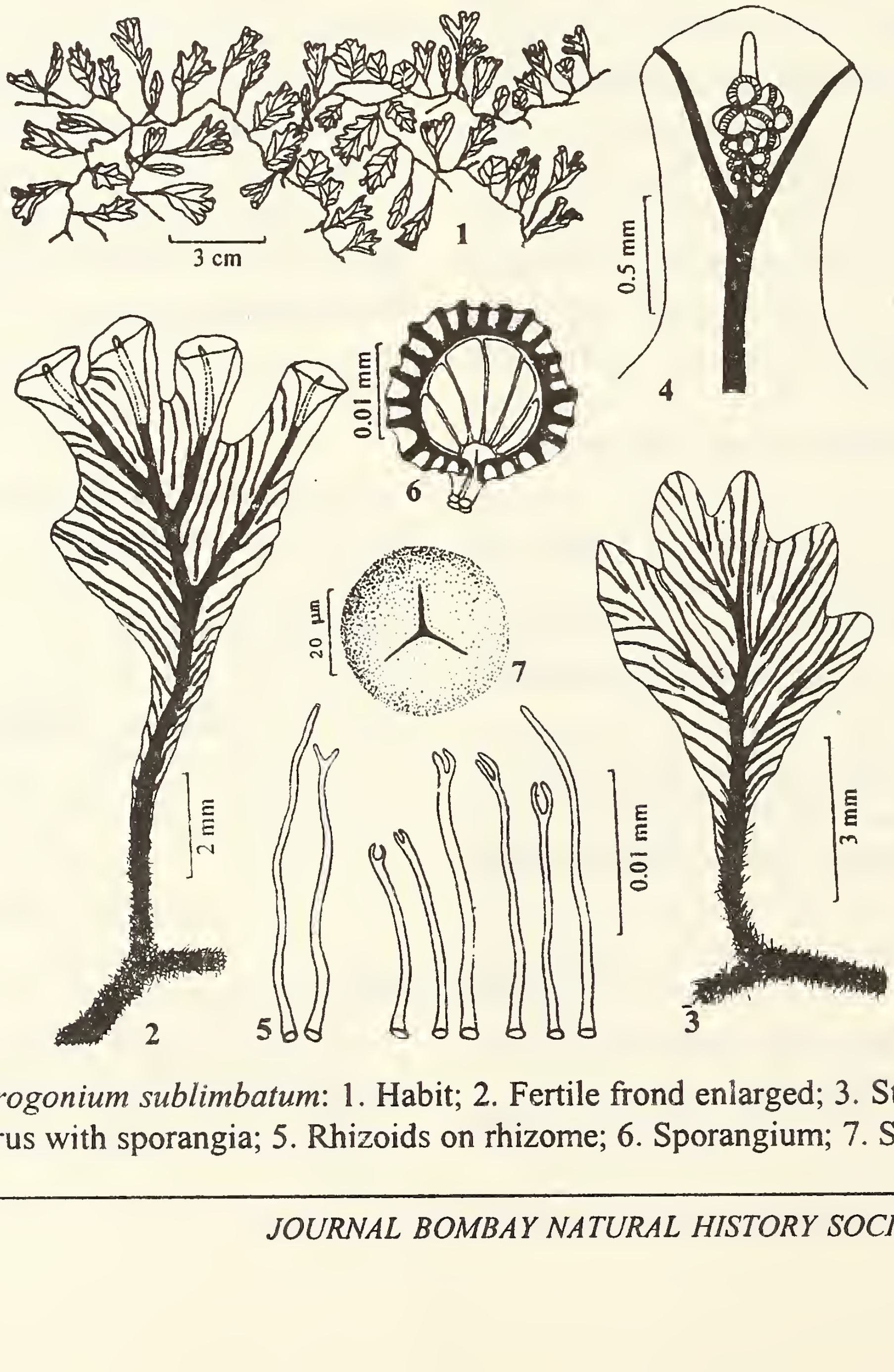
32. *MICROGONIUM SUBLIMBATUM* (C. MULL.) v.d.B: HYMENOPHYLLACEAE — A NEW RECORD FOR SOUTH INDIA

(*With seven text-figures*)



Figs 1-7: *Microgonium sublimbatum*: 1. Habit; 2. Fertile frond enlarged; 3. Sterile frond; 4. A sorus with sporangia; 5. Rhizoids on rhizome; 6. Sporangium; 7. Spore.

During our revisionary studies on ferns (Hymenophyllaceae) in South India, we came across an interesting specimen from the evergreen forests of Thommankuthu in Idukki dist., on the foothills of the Western Ghats of Kerala. It was found on tree trunks just above ground level, covering the bark of trees near the Thommankuthu waterfall. The plant has slender, creeping, irregularly branched, blackish rhizomes, with pale green fronds. On comparing with literature, we identified it as *Microgonium sublimbatum* (C. Mull.) v.d.B. In India it is reported only from Khasia hills, Eastern Himalayas (Iwatsuki 1985). The specimens have been deposited in the Calicut University Herbarium (CALI).

Distribution: Himalaya (Khasia Hills), Burma (=Myanmaar), Thailand, Indochina, Malesia.

Ecology: An extremely rare species growing on moist tree trunks just above ground level.

Specimen examined: Thommankuthu forest, Idukki dist., Kerala; 27.xii.1996, Abdul Hameed CU 34802 (CALI).

Note: This taxon differs from *Microgonium henzaianum* (Parish *ex.* Hook.) which has dark green fronds, broadest near the apex, and involucres as wide as long. It lacks continuous submarginal false vein, which is the identifying character of *Microgonium bimarginatum*. According to Holttum (1954) and Copeland (1933), *M. sublimbatum* is larger than *M. bimarginatum*. But our specimen is almost the same size as that of *M. bimarginatum* collected from different parts of Kerala.

January 9, 1998

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33. PHENOLOGY OF *NAREGAMIA ALATA* (MELIACEAE) FROM WESTERN MAHARASHTRA

(*With one plate*)

Naregamia alata W. & A. (Meliaceae) is an endemic herb species in western Maharashtra. We observed it in the field and attempted its acclimatization in a nursery. The plant is under observation for the last three years. A change in the flowering character was recorded, which is presented in this communication.

During a botanical excursion to the coastal areas of Maharashtra, (Vengurla to Goa border area) we collected live specimens of *Naregamia alata* W. & A. (Meliaceae) on the way from Akeri to Vengurla. From the literature, we found that the species is endemic and confined to selected areas on the west coast of India. In India it occurs only in the Western ghats from Konkan southwards (Dalzell and Gibson 1861, Hooker 1875, Cooke 1901, Gamble 1910, Almeida 1990). It is also recorded as a medicinal plant (Chopra *et al.* 1958).

Young plants of *Naregamia alata* were collected and kept for acclimatization in a nursery at the Agharkar Research Institute, Pune. The plants have thrived well. The recorded length of

TABLE 1

Observations	Habit	Leaves	Flowers	Fruits	Seed
Literature	Herb/Undershrub	Cuneate, obovate	Solitary 3-5 cm long		Brown, truncate
Field	Woody herb	Cuneate, trifoliate petiole winged	Not seen	3 valved 1-1.2 cm in diameter	Brown, truncate
Herbarium	Woody herb	Cuneate, trifoliate petiole winged	Solitary 2-3 cm long	3-valved 0.8-1 cm in diameter	Brown truncate
Nursery	Woody herb 20-30 cm high	Cuneate, trifoliate petiole winged leaflets obtusely lobed, terminal leaflets longer than lateral	2-3 axillary yellowish-white, 0.5-0.6 cm long, anthers orange, forming tube, stigma greenish white	Tri-cornered 0-8-1 cm in length	Brown 0-4-0.6 cm long, truncate at both ends

Flowering fruiting: October to December

Naregamia alata flowers is 3-5 cm. But the flower size in the nursery specimens differs from this appreciably. Materials from herbaria at the Botanical Survey of India Western Circle, Pune, Agharkar Research Institute, Pune, and National Botanical Research Institute, Lucknow were studied. Observations on exomorphic characters were noted and are given in the table above.

Dec. 23, 1997

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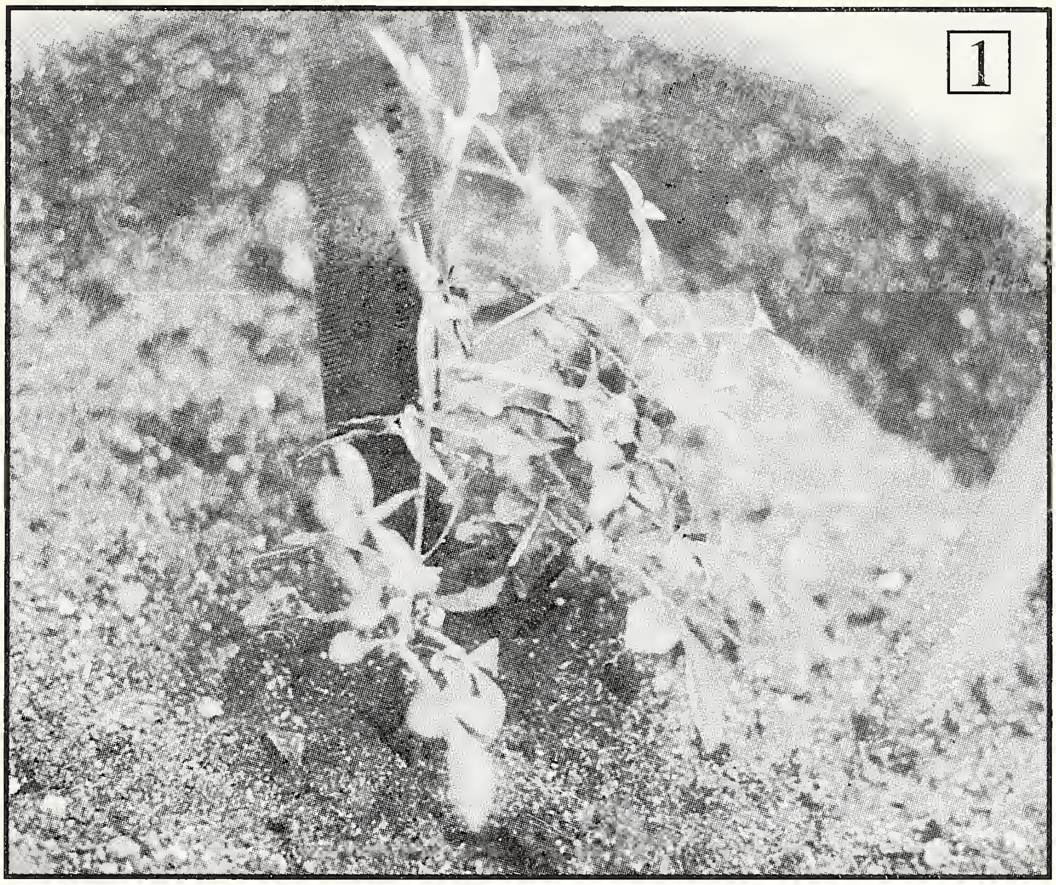
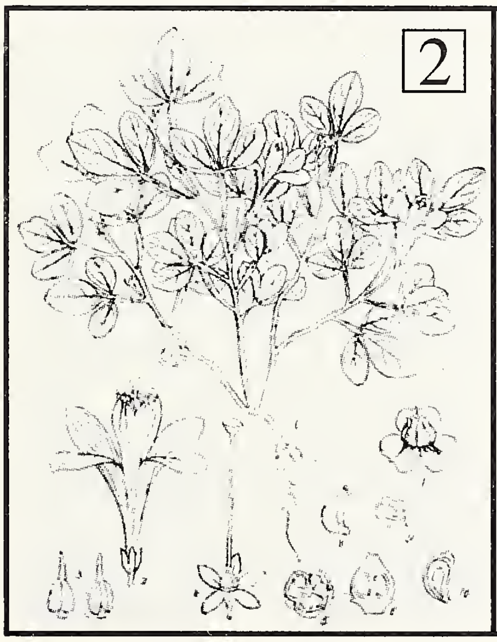
34. *DESMODIUM* DESV. (FABOIDEAE) IN EASTERN GHATS, INDIA: A SYSTEMATIC SURVEY

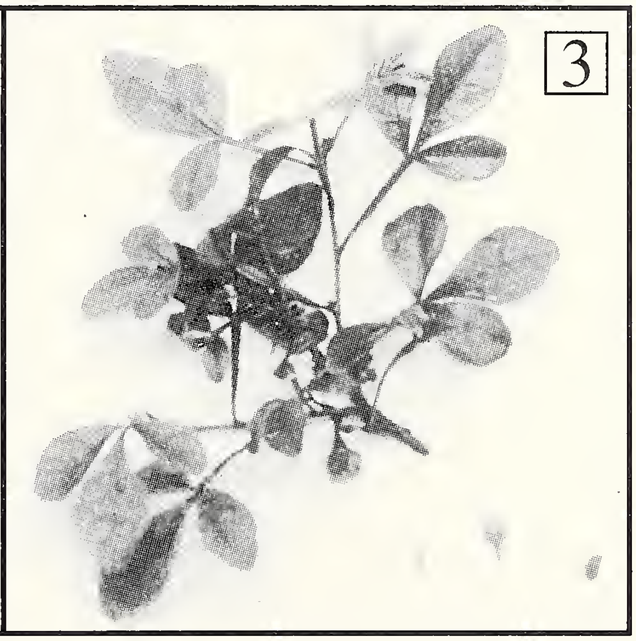
(*With two text-figures*)

The botany of the Eastern Ghats has not been adequately studied and no detailed Flora is available so far. The flora of Eastern Ghats of Orissa is covered by the work of Haines (1921), while Gamble and Fischer (1915-1935) reported on Andhra Pradesh and Tamil Nadu in his FLORA OF PRESIDENCY OF MADRAS. Recently Saxena and Brahmam (1994), Ellis (1987), Subba Rao (1977), Pullaiah and Chennaiah (1997), Matthew (1993) and others have contributed to our knowledge of the flora in some selected regions of the Eastern Ghats. Mani (1974), Nayar *et al.* (1984) and Raju *et al.* (1987) reported on the vegetation and phytogeography, endemic and rare

A.S. Upadhye and M.S. Kumbhojkar: *Naregamia alata* PLATE 1







1. *Naregamia alata* growing at ARI nursery; 2. Line drawing of *Naregamia alata* from medicinal plants, Kirtikar and Basu, 1933. Lalit Mohan Basu, Allahabad;
3. Twig from plant growing in nursery showing flower, fruit and seed character.

plants and potentially important plants of Eastern Ghats.

STUDY AREA: The Eastern Ghats are located between 11° 30' to 22° N lat. and 76° 56' E to 86° 30' E long. They extend in a northeast, southwest strike in the Indian peninsula, covering an area of about 75,000 km^2, from the Mahanadi basin to the north, to the Nilgiri hills at the southern end. Eastern Ghats are thus spread through the States of Orissa, Andhra Pradesh and Tamil Nadu. They are divided into the northern Eastern Ghats and southern Eastern Ghats and irrigated by the rivers Mahanadi, Godavari and Krishna. The region has tropical monsoon climate, receiving rainfall from both southwest monsoon and northeast monsoon.

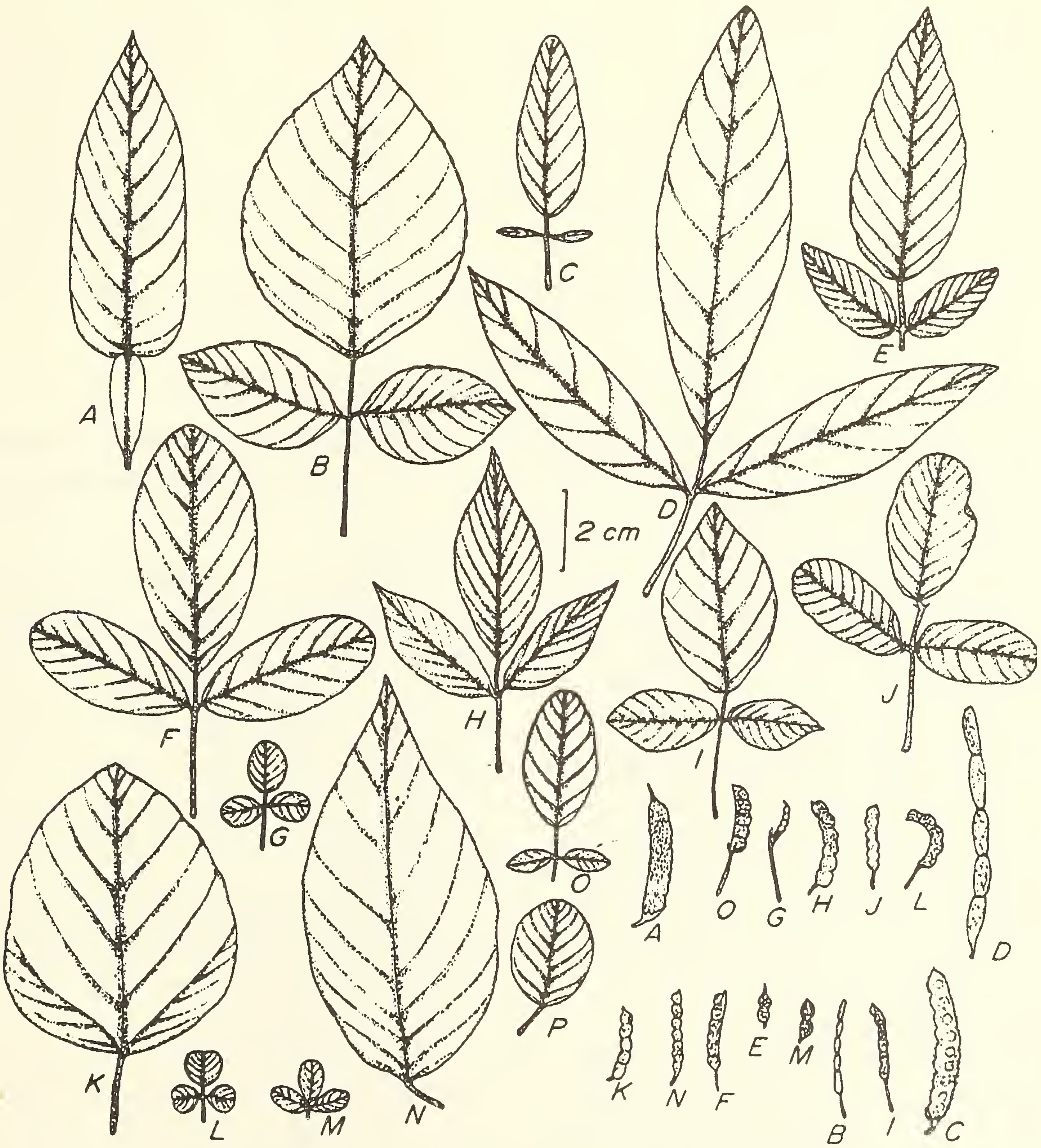


Fig. 1: Leaves and Pods of *Desmodium* spp.: A. *Desmodium triquetrum*; B. *D. laxiflorum;* C. *D. motorium;* D. *D. caudatum;* E. *D. pulchellum*; F. *D. heterocarpon*. G. D. *alysicarpoides*; H. *D. triangulare*; I. *D. pryonii*; J. *D. dichotomum*; K. *D. velutinum*; L. *D. triflorum*; M. *D. biarticulatum*; N. *D. gangeticum*; O. *D. heterophyllum*; P. *D. benthamii*.

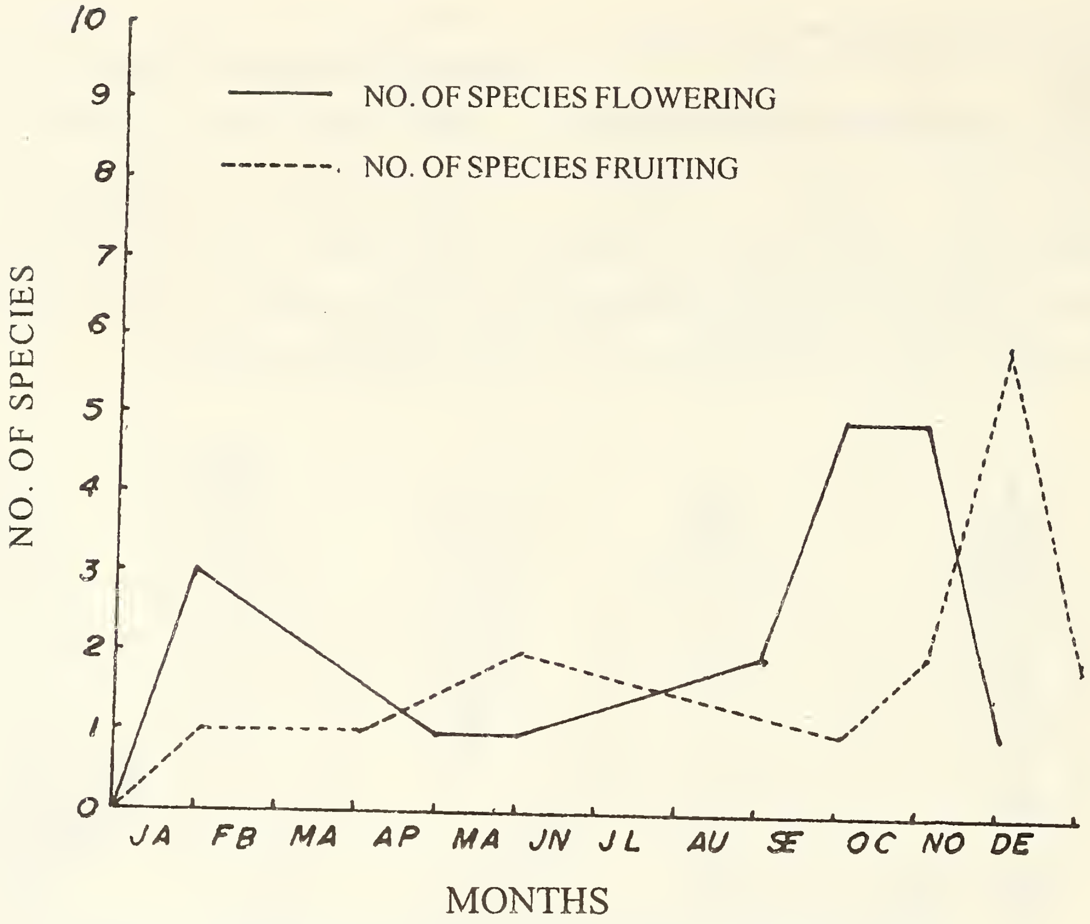


Fig. 2: Phenology of *Desmodium* spp. in Eastern Ghats.

Periodical collections were made during 1994-1997 throughout the Eastern Ghats. For the present study, the Eastern Ghats have been divided into eight regions representing different types of habitats and vegetation. The material has been identified after scrutiny at the herbaria of Botanical Survey of India (BSI) both at CAL and MH.

The genus *Desmodium* (Faboideae) is mainly of tropical and sub-tropical distribution (Willis 1973) and comprises of 450 species, of which nearly 47 species, 12 sub-species and 8 varieties are found in India (Sanjappa, 1991). Some species of the genus are rather scarcely represented. In the Eastern Ghats, *Desmodium* is represented by 18 species which is the third largest genus after *Crotalaria* (49 species) and *Indigofera* (25 species).

General features of the genus: These are prostrate herbs to shrubs, leaves simple and trifoliolate (Fig. 1). Flowers in terminal or axillary racemes, sometimes in axillary umbels. Calyx tube short, campanulate or turbinate, corolla exserted. Stamens diadelphous, sometimes monadelphous. Pods consisting of 2-9, 1-seeded articles which are usually indehiscent and easily separating, less often dehiscent at one suture. Some compressed, reniform and estrophiolate.

Phenologically, all *Desmodium* species are annuals. Out of 18 species, 3 species i.e., *D. ferrugineum, D. repandaum* and *D. triflorum* bear fruit throughout the year. A month-wise analysis of the data has been given in Fig. 2. The maximum number of species flower in September and October (5 species each month). The maximum number of species (6 species) fruit in November.

Table 1 shows the distribution of various *Desmodium* spp. collected from eight different regions of the Eastern Ghats. Out of 18 species, 5 are restricted in their distribution i.e. *Desmodium caudatum* is rare in Paderu, Vishakhapatnam, Andhra Pradesh; *D. ferrugineum* and *D. repandum* are common in Shevaroy and Kolli hills; *D. pryonii* is rare in Udayagiri of Seshachalam hill of Nellore dist., and *D. biarticulatum* is occasional in Araku valley and Seshachalam hill ranges.

TABLE 1
DISTRIBUTION OF *DESMODIUM* SPECIES IN VARIOUS REGIONS OF EASTERN GHATS

	North E.G.			South E.G.					
Species	I	II	III	IV	V	VI	VII	VIII	Frequency
Desmodium alysicarpoides Van Meeuwen	+	+	+	-	-	-	+	-	Occasional
D. benthamii Balakr.	+	+	+	-	-	-	-	-	Rare
D. biarticulatum (L.) F.V. Muell	-	-	+	-	+	-	-	-	Occasional
D. caudatum (Thumb.) DC.	-	-	+	-	-	-	-	-	Rare
D. dichotomum (Wild.) DC.	+	+	-	+	-	+	*	*	Occasional
D. ferrugineum Wall.	-	-	-	-	-	+	+	-	Common
D. gangeticum (L.) DC.	+	+	+	+	*	+	*	*	Common
D. heterocarpon (L.) DC.	+	+	+	+	*	+	*	+	Common
D. heterophyllum (Wild.) DC.	+	-	+	+	-	-	+	-	Rare
D. laxiflorum DC.	+	+	+	*	+	+	+	-	Common
D. motorium (Houtt.)	*	+	+	+	*	-	-	-	Occasional
D. pryonii DC.	-	-	-	-	+	-	-	-	Rare
D. pulchellum (L.) Benth.	+	+	+	*	+	-	+	+	Common
D. repandum (Vahl) DC.	-	-	-	-	-	*	*	-	Common
D. triangulare (Retz.) Merr.	+	+	+	+	+	+	-	-	Occasional
D. triflorum (L.) DC.	*	*	*	*	*	*	*	*	Common
D. triquetrum (L.) DC.	+	+	+	+	-	-	-	-	Occasional
D. velutinum (Wild.) DC.	+	+	+	+	+	*	+	-	Common

SYMBOLS USED: I) Koraput range; II) Mahendragiri; III) Araku valley & Madgol hills; IV) Nallamalais; V) Seshachalam hills; VI) Shevaroy hills; VII) Kolli hills; VIII) Javadi hill *) Abundant; +) Present; -) Absent;

Desmondium benthamii is restricted to northern Eastern Ghats. *Desmodium gangeticum, D. heterocarpon, D. laxiflorum, D. triflorum, D. pulchellum* and *D. velutinum* are common throughout the Eastern Ghats. *D. alysicarpoides, D. dichotomum, D. heterophyllum, D. motorium, D. triangulare* and *D. triquetrum* are occasional in their distribution in different regions.

ACKNOWLEDGEMENTS

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March 10, 1998

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35. *EUPATORIUM ADENOPHORUM* SPRENG. — A NEW RECORD FOR MADHYA PRADESH

The genus *Eupatorium* L. with about 400 species is mostly found in Central and South America, Asia and Africa. Hooker (1882) has reported only 2 species *E. glandulosum* H.B.K. and *E. reeversii* Wall. while Rao and Rao (1980) have given a detailed account of 12 species from the northeastern region of India.

This study is based on survey and collection by the authors and consultation of herbarium of Botanical Survey of India, Central Circle, Allahabad. This species has not been reported from central India to date (Verma *et al.* 1993). The authors, while conducting a survey of medicinal plants growing in Torenga forest, Raipur dist., Madhya Pradesh in 1991 and 1992, came across *E. adenophorum* Spreng, growing wild.

Eupatorium adenophorum Spreng., Syst. 3:420, 1826; Rao & Rao Proc. Indian Nat. Sci. Acad. B. 46. 4: 587-592, 1980.

Straggling perennial undershrubs. Stem densely covered with stalked glands. Leaves opposite, broadly elliptic or rhomboid, angular sharply pointed, serrate above, base cuneate. Flower heads clustered, white, pedicelled, 40-60 flowered; involucral bracts 20 in two rows, lanceolate acuminate, striate, glandular-ciliate. Corolla tube white, abruptly dilated. Achenes black, glabrous, crowned by pappus of 10-20, whitish hairs.

Fl. & Fr.: February - May.

Specimen examined: Torenga Forest, Raipur dist., M.P., Field Nos. 6708, 7148.

Distribution: Native to Mexico, naturalized in Northeastern India, Tamil Nadu, Uttar Pradesh and Kerala.

January 19, 1998

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36. *JASMINUM CAUDATUM* WALL. EX LINDL. (OLEACEAE) A NEW RECORD FOR WEST BENGAL

During an ethnobotanical survey in Jalpaiguri dist., West Bengal, a specimen of *Jasminum* sp. was collected, which was identified by Dr. U.C. Bhattacharyya as *Jasminum caudatum* Wall. ex Lindl., hitherto unreported from West Bengal.

Jasminum caudatum: Wall. ex Lindl. in Bot. Reg. 28: *t.* 26. 1842; C.B. Clarke in Hook. f., Fl. Brit. India 3: 601. 1882; Haines, Bot. Bihar & Orissa 526. 1922; Fischer in Rec. Bot. Surv. India 12(2): 110. 1938; Kanjilal *et al.*, Fl. Assam 3: 232. 1939; Balakr., Fl. Jowai 1: 302. 1981; Hara *et al.*, Enum. Fl. Pl. Nepal 3: 80. 1982; Deb, Fl. Tripura 2: 5. 1983.

Type: *wallich* Cat. num. list no. 2884 (K-W, microf. - CALI).

Distribution: INDIA - Andaman Islands, Arunachal Pradesh, Assam, Meghalaya, Sikkim, Tripura and West Bengal; BANGLADESH, NEPAL and BHUTAN.

Use: The decoction of the root is used by Totos tribals as a gargle to cure toothache.

December 23, 1997

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37. *BRACHIARIA ERUCIFORMIS* (J.E. Sm) GRISEB. A NEW RECORD FOR KERALA

While exploring Kozhikode dist., Kerala for grasses, I found *Brachiaria eruciformis* growing by the side of a footpath in Kozhikode city. The species has not been mentioned in literature (Bor 1973, Nair and Sreekumar 1991) as occurring in Kerala, though it has been reported earlier from Bihar, Karnataka and Bengal and has been collected by me from Hyderabad, Andhra Pradesh during October 1996.

Distribution: India westwards to Spain and North Africa.

The species is new to Kerala and probably introduced from other states by means of the grass or seeds transported by interstate vehicular traffic.

Brachiaria eruciformis can be distinguished from other species of the genus by the linear panicle with erect racemes of closely crowded, softly hairy spikelets, 2-2.5 mm long and a hairy rachis. The lower glume is a minute scale 0.3 mm long.

This species is not a fodder grass.

The collection from Kozhikode was made on January 31, 1997.

December 23, 1997

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